THE PATH FORWARD FOR WOOD PRODUCTS:

A GLOBAL PERSPECTIVE

Baton Rouge, Louisiana, USA
October 5th-8th 2016

WoodEMA, i.a. – International Association for Economics and Management in Wood Processing and Furniture Manufacturing

Forest Products Society

Louisiana Forest Products Development Center

Louisiana State University Agriculture Center

THE PATH FORWARD FOR WOOD PRODUCTS: A GLOBAL PERSPECTIVE

Proceedings of Scientific Papers

Baton Rouge, Louisiana, USA
October 5th-8th 2016

THE PATH FORWARD FOR WOOD PRODUCTS: A GLOBAL PERSPECTIVE

Proceedings of Scientific Papers

Publisher: WoodEMA, i.a. – International Association for Economics and Management in Wood Processing and Furniture Manufacturing, Svetošimunska 25, Zagreb, Croatia

Editor-in-chief: prof. Denis Jelačić, PhD.

Cover: Boris Horvat

Edition: 100 copies

ISBN: 978-0-692-76612-5

Preface

This proceedings of scientific papers is a compilation of articles submitted by authors that convey results of recently completed research. These results were presented at the international event titled THE PATH FORWARD FOR WOOD PRODUCTS: A GLOBAL PERSPECTIVE, held in Baton Rouge, Louisiana, USA, October 5th-8th 2016. This event was organized as the 9th international scientific conference WoodEMA 2016.

This year, for the 9th Annual Conference, there were many "firsts". For the first time the conference was being held outside of Europe, in Baton Rouge, Louisiana, USA. WoodEMA was partnering for the second year with the Forest Products Society as well as the Louisiana Forest Products Development Center and the Louisiana State University Agricultural Center. For the first time, we joined the U.S. Forest Service as a conference partner.

The proceedings and conference reflected the conference theme: The Path Forward for Forest Products: A Global Perspective. The main goal of the event was to exchenge and transfer knowledge by international experts and scientists in an array of topics and issues facing the global forest and forest products sectors.t. Scientists and experts, 61 of them from 14 countries of 4 continents (11 European countries, India, Nigeria and United States of America), in 28 articles, presented their points of view on technology, organisation, economics, marketing, trade and environmental issues which are important in market competitiveness for industry, regardless of country or region.

Prof. Richard Vlosky, PhD.
WoodEMA president

List of authors:

Sergey ZALESOV (RUS)
Anton OPLETAEV (RUS)
Natalia PRYADILINA (RUS)
Roy DAMARY (GBR)
Marko DUŠAK (CRO)
Denis JELAČIĆ (CRO)
Tomaš SVOBODA (CZE)
Vojtech VOKATY (CZE)
Vladimir ZABORSKY (CZE)
Zuzana GAFFOVA (CZE)
Vaclav KUPČAK (CZE)
Jiri TAUBER (CZE)
Milan SIMEK (CZE)
Zdenek HOLOUS (CZE)
Jaroslav SVOBODA (CZE)
Emilia GRZEGORZEWSKA (POL)
Renata STASIAK BETLEJEWSKA (POL)
Robert ULEWICZ (POL)
Erika LOUČANOVA (SVK)
Martina KALAMAROVA (SVK)
Miriam OLŠIAKOVA (SVK)
Rossitsa CHOBANOVA (BUL)
Magdalena WIECKOWSKA (POL)
Slavica PETROVIĆ (SRB)
Hubert PALUŠ (SVK)
Jan PAROBEK (SVK)
Richard VLOSKY (USA)
Darko MOTIK (CRO)
Leon OBLAK (SLO)
Matej JOŠT (SLO)
Branko GLAVONJIĆ (SRB)
Roman DUDIK (CZE)
Leszek WANAT (POL)
Jože KROPIVŠEK (SLO)
Anton ZUPANČIĆ (SLO)
Vladislav KAPUTA (SVK)
Mikulaš ŠUPIN (SVK)
Anna KRŠAKOVA (SVK)
Bharad ABHISHEK (IND)
Annika HYYTIA (FIN)
Jan DVORAČEK (SVK)
Anna DOVČIKOVA (SVK)
Holger WEIMAR (GER)
Kristina KLARIĆ (CRO)
Andreja PIRC BARČIĆ (CRO)
Dominika BURYOVA (SVK)
Pavol SEDLAK (SVK)
Valentino SLIVAR (CRO)
Ivana HIDEG (CRO)
Lovro BELINA (CRO)
Franciska KLANFAR (CRO)
Hana MAT'OVA (SVK)
Miroslava TRIZNOVA (SVK)
Michal DZIAN (SVK)
Jan CHUDOBIECKI (POL)
Tomasz POTKANSKI (POL)
Leszek WANAT (POL)
Roman DUDIK (CZE)
Olusola Samuel AREO (NIG)
Olajide Razaq ADEJOBA (NIG)
Ajodeji O. OMOLE (NIG)

CONTENTS

Zalesov S.; Opletaev A.; Pryadilina N.; Damary R.
FASTIGIATA URALICA – A NEW DECORATIVE FORM OF SIBERIAN SPRUCE
(PICEA OBOVATA LEDEB.) FOR LANDSCAPING 1

Dušak, M.; Jelačić, D.
PRODUCTION MANAGEMENT SYSTEM OF WOOD PROCESSING SME'S IN CROATIA 9

Svoboda, T.; Vokatý, V.; Záborský, V.; Gaffová, Z.
ELASTICITY MODULUS AS A FUNCTION OF SELECTED FACTORS 15

Vokatý, V.; Svoboda, T.; Kupčák, V.; Gaffová, Z.; Záborský, V.
BENDING STRENGTH AND PROPORTIONALITY LIMIT OF CYCLIC LOADING ON
BEECH AND ASPEN SOLID WOOD 23

Tauber, J; Simek, M; Holus, Z; Svoboda, J.
NEW TRENDS IN UPHOLSTERED FURNITURE 35

Grzegorzewska, E.; Stasiak-Betlejewska R.
DEVELOPMENT OF THE WOODWORKING INDUSTRY PRODUCTION POTENTIAL IN POLAND
– THE ECONOMICAL DIMENSION 43

Ulewicz, R.
QUALITY MANAGEMENT SYSTEM OPERATION IN THE WOODWORKING INDUSTRY 51

Loučanová, E.; Kalamárová, M.; Olšiaková, M.
THE NEED OF INTRODUCTION OF ECO-INNOVATION ASPECTS IN PACKAGING
FROM THE CUSTOMERS' PERSPECTIVE 57

Chobanova R.
INTENSIFYING SMES BUSINESS NETWORKS IN FORESTRY 61

Grzegorzewska E., Więckowska M.
THE INFLUENCE OF EXPORT ACTIVITY ON INNOVATIVENESS
OF POLISH FURNITURE MARKET 67

Petrović, S.
EUROPEAN ECO LABELS FOR WOOD FLOORING 75

Paluš H.; Parobek J; Vlosky P. R; Motik D.; Oblak L.; Jošt M.; Glavonjić B.; Dudík R.; Wanat L.
SURVEY OF CHAIN OF CUSTODY CERTIFICATION IN THE COUNTRIES
OF CENTRAL AND SOUTH EUROPE 85

Kropivšek, J.; Oblak, L.; Zupančič, A.; Jošt, M.
IMPACT OF ORGANIZATIONAL LEARNING ON THE DEVELOPMENT OF COMPETENCIES:
CASE OF SLOVENIAN WOOD-INDUSTRY 93

Parobek, J.; Paluš, H.
THE CONCEPT OF CASCADED USE OF WOOD IN SLOVAKIA 101

Kaputa, V; Šupín, M; Kršáková, A.
A PUBLIC VIEW ON ETHICAL PARTNERSHIP 107

Vlosky, R.; Abhishek, B.
EFFECTS OF THE GREAT RECESSION ON PRIMARY AND VALUE-ADDED
WOOD PRODUCTS INDUSTRY SECTORS: A CASE STUDY IN LOUISIANA, USA 113

Hyytiä, A.
CSR, BUSINESS AND MARKETING AND INNOVATION IN FOREST POLICY AND
SUSTAINABILITY IN THE FOREST-BASED MARKETS WITH STAKEHOLDERS 123

Dvořáček, J.; Dovčíková, A.
CSR AND LEGISLATION FRAME IN THE SLOVAK REPUBLIC 129

Weimar, H.
FROM EMPIRICAL STUDIES TO BIOENERGY STATISTICS: BRIDGING THE GAP
OF UNRECORDED WOOD-BIOENERGY IN GERMANY 133

Klarić, K; Motik, D; Pirc Barčić, A.
FINANCIAL ASPECTS OF FSC COC WOOD INDUSTRY CERTIFICATE HOLDERS 143

Stasiak-Betlejewska, R.; Ulewicz, R.
THE EFFECTIVENESS OF SELECTED MACHINERY AND EQUIPMENT
IN THE WOODWORKING JOINERY 149

Búryová, D.; Sedlák, P.
WOOD LOG HOUSE – COMPREHENSIVE THERMAL PREDICTION AND
ENERGY CONSUMPTION QUANTIFICATION 157

Pirc Barčić, A; Motik, D; Slivar, V; Hideg, I; Belina, L; Klanfar, F.
WOOD PRODUCTS USAGE IN RURAL TOURISM BUILDINGS 167

Stasiak-Betlejewska, R.
THE IMPLEMENTATION OF PROCEDURES ENSURING THE PRODUCT QUALITY
IN THE WOODEN CONSTRUCTION INDUSTRY ENTERPRISE 173

Maťová, H.; Triznová, M.; Dzian, M.
DIFFERENT PROFILES OF BRAND PERSONALITY – THE RESULT OF TWO INDEPENDENT
MEASUREMENTS 181

Chudobiecki, J.; Potkański, T.; Wanat, L.
INTERMUNICIPAL AND INTERSECTORAL COOPERATION AS A TOOL OF SUPPORTING
LOCAL ECONOMIC DEVELOPMENT: SELECTED EXAMPLES FROM THE FOREST
AND WOOD-BASED SECTOR IN POLAND 187

Dudik, R.
FUNCTION AND USE OF PEFC C-O-C CERTIFICATION IN THE EU TIMBER REGULATION SYSTEM OF DUE DILIGENCE 197

Areo, O.S.; Adejoba, O.R.; and Omole, O.A.
VOLUME ESTIMATION OF SAWMILL WASTE IN FORESTRY RESEARCH INSTITUTE OF NIGERIA (FRIN) 205

FASTIGIATA URALICA – A NEW DECORATIVE FORM OF SIBERIAN SPRUCE (PICEA OBOVATA LEDEB.) FOR LANDSCAPING

Zalesov S.; Opletaev A.; Pryadilina N.; Damary R.

ABSTRACT

In this paper the authors describe the shapes of Siberian spruce used for landscaping in the Russian Federation, with focus on an attractive new decorative form of Siberian spruce (genus Picea). Spruce are suitable both for avenue planting and also for landscaping. Considerable interest has been generated in the territory of Sverdlovsk region for new form of spruce with a unique combination of columnar crown and drooping spiral branching. The appearance is similar to the cypress. A columnar crown has great potential in landscape architecture. The authors propose naming it as a reflection of the crown, the place of discovery and the name of the discoverer: Siberian spruce 'Fastigiata Uralica' (picea obovata ledeb var 'Fastigiata Uralica' Opletaev). Once large-scale cultivation of Siberian spruce 'Fastigiata Uralica' is achieved, (and the research team itself will undertake this) the tree will be brought to the market for landscaping usage.

In the paper are also discussed the economic aspects of the potential market, including branding. Keywords: Siberian spruce, columnar crown shape, drooping branch shape, spiral branching, Picea obovata Ledeb. 'Fastigiata Uralica' Opletaev, economic aspects of landscape design.

1. INTRODUCTION

Enhancing the welfare of the population includes meeting the desire of citizens to improve the environment. In this context much attention is paid to landscaping. However, the creation an aesthetically appealing landscape is difficult owing to the limited range of tree species suitable for the harsh climatic conditions. Foresters, both in Russia and abroad, are seeking to expand the range of woody plants by the introduction of exotics, as well as the selection of decorative forms of local flora species [Zalesov, Platonov, Gusev, 2011; Kozhevnikov, 2013; Krekova, Dancheva, Zalesov, 2015].

Particular attention is paid to conifers, which lend themselves to decorative year-round landscaping. The most attractive in this respect are the various species of the genus Picea [Alexandrov, 2010].

2. MATERIALS AND METHODS

The range of woody plants in the taiga zone is rather limited. This is due primarily to the harsh climatic conditions, which limit the appearance and natural growth of thermophilic species. Expanding biodiversity in these conditions can be achieved only by systematic work on the introduction of plants and the identification of promising species and forms. Indicators for assessing the viability of plants and prospects for their cultivation are typically:

the degree of maturity of shoots
winter hardiness,
the regularity of shoot growth
the ability to develop genetic and cultivation methods.

The most successful methods for evaluating the prospects of woody plants are the methods of the Main Botanical Garden [Kupriyanov, 2004], as well as a modified version of the proposed Gusev et al [Gusev, 2009].

3. COMMON FORMS OF SPRUCE IN RUSSIA

The various forms of decorative fir trees (spruce) have long been widely used in landscaping. The species shows significant polymorphism – there are about 130 natural and garden forms of European spruce (Picea abies (L.) H. Karst.). The decorative forms include: columnar, pyramidal, weeping and subramose. Diverse

dwarf forms are found with a cushion, spherical and hemispherical, and with a cone-shaped, as well as pyramidal crown.

Not all forms are used in Russia and especially in the Urals. For landscaping Russian cities the most popular decorative spruce varieties with their weeping form and various original crowns are: (Figure 1):
Norway spruce 'Acrocona' (P. abies 'Acrocona'),
Norway spruce 'Virgata' or snake (P. abies 'Virgata'),
Norway spruce 'Cranstonii' (P. abies 'Cranstonii'),
'Pendula Major' (P. abies 'Pendula Major'),
'Frohburg' (P. abies 'Frohburg'),
Norway spruce 'Formanek' (P. abies 'Formanek')

Figure 1. From left to right: Norway spruce 'Acrocona' , Norway spruce 'Virgata' (snake), Norway spruce 'Cranstonii''

Figure 2. From left to right: spruce 'Pendula Major', spruce 'Frohburg', Norway spruce 'Formanek'

Dwarf forms of Norway spruce are widely used in landscape compositions, both in single and in group form. Using dwarf forms improves the aesthetic appeal of ornamental plantings, especially the lower tiers. Often their use in city gardening is difficult because of the low resistance to most forms of air pollution.

In Russia the common dwarf forms of Norway spruce are:

- 'Barryi' (P. abies 'Barryi'),
- 'Push' (P. abies 'Push'),
- 'Will's Zwerg ' (P. abies 'Will's Zwerg').
- Also widely used in landscaping are the dwarf forms of Norway spruce known as:
- 'Little Gem' (P. abies 'Little Gem'),
- 'Pumila Glauca ' (P. abies 'Pumila Glauca'),
- 'Tabuliformis ' (P. abies Tabuliformis') and other (Figure 3).

Figure 3. From left to right: Norway spruce 'Barryi', Norway spruce 'Tompa', Norway spruce 'Will's Zwerg'

Of particular note is a dwarf form, which is well established in the Urals - the spruce 'Nidiformis' (nestlike) (Picea abies 'Nidiformis'), with a cushion-shape crown and centre (Figure 4).

Figure 4. Norway spruce 'Nidiformis' (nestlike) (Picea abies 'Nidiformis')

Siberian spruce has only two described forms - blue Siberian spruce (P. obovata var. Coerulea Malyshev) and Pechorian spruce (P. obovata ssp. petchorica Govor), neither of which are of interest for gardening.

4. THE SUBJECT OF RESEARCH – A NEW FORM OF SIBERIAN SPRUCE

In the Sverdlovsk region a single example has been found of a new form of Siberian spruce. Its appearance very different from that of the typical spruce. Views of the crown and branches are shown in Figure 5.

Figure 5. On the left - a general view of the new decorative form of Siberian spruce; right, its drooping, spiralling branches

The uniqueness of this spruce lies in the simultaneous combination a narrow columnar crown with drooping spiral branching, and suggests the high value of this form of Siberian spruce in landscape architecture.

5. A NEW BRAND ON THE MARKET FOR LANDSCAPE DESIGN

The preliminary title of this new form of Siberian spruce is P. obovata 'Fastigiata Uralica' Opletaev. "Fastigiata" describes a tree with a columnar shape, numerous branches, with shoots firmly pressed against the trunk and facing down. Since this taxon has a different set of characteristics – a pronounced narrow columnar crown shape and drooping branches of the spiral form, to give it the name reflecting only one morphological feature is not quite enough. It is therefore proposed to call the new form to reflect the crown shape, the place of its discovery and the discoverer. This leads to Siberian spruce 'Fastigiata Uralic' (P. obovata 'Fastigiata Uralica' Opletaev).

As the new form of Siberian spruce has great decorative potential, the authors propose starting the process of branding, industrial propagation, cultivation and promotion of 'Fastigiata Uralica' in the market for landscape design and urban greening.

6. OUTLOOK

The authors have assessed the outlook of the genus Picea using a combination of factors, in accordance with the guidelines of the Central Botanical Garden and a number of other works [Bolotov, 1992; Gusev 2011; Zalesov et al., 2014].

Table 1. Suitability of the genus Picea for Cultivation of Picea

Outlook	Taxon designation	Score							
		Maturing of the seedlings	Winter hardiness	Safeguarding of the habitat	Ability to form seedlings	Growth in height	Ability for generative reproduction	Ease of propagation	Overall assessment of likely introduction
Most promising	1. Siberian spruce 'Fastigiata Uralica' (Picea obovata var. 'Fastigiata Uralica' Opletaev)	20	25	10	5	5	25	5	95
Promising	Prickly spruce (Picea pungens Engelm.)	15	15	10	3	5	25	5	78
Unpromising	Norway spruce (European) (Picea abies (L.) Karst.)	15	10	5	1	5	1	1	38

Conclusion: the Siberian spruce 'Fastigiata Uralica' belongs to the most promising group of members of the genus Picea in the Urals and in Russia.

7. MARKET PROMOTION

In the Russian market there is a lack of diversity of ornamental forms of native plant species. To date, landscaping in Russia has relied on trees imported from Germany, Poland, Holland and even Italy with its warm climate. Since these imported spruce are used to a mild climate, they die in the Russian frosts.

The authors suggest bringing Fastigiata Uralica to the market for landscaping and urban greening, as suggested in Figure 6.

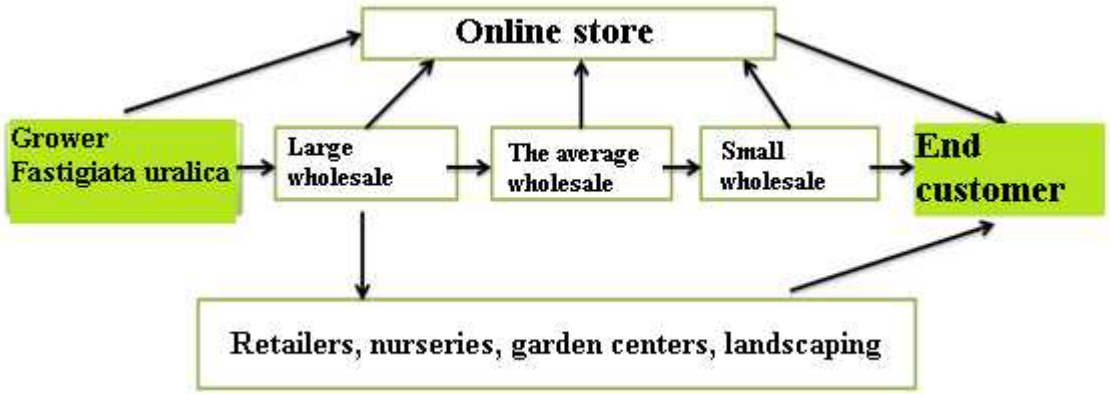


Figure 6. Marketing route for Siberian spruce 'Fastigiata Uralica'

Potential buyers: home chain stores (OBI, Auchan, Leroy Merlin, etc), garden centres, tree nurseries, vegetation enterprises.

8. THE CULTIVATION PROCESS

For the reproduction of 'Fastigiata Uralica', members of the Ural State Forest Engineering University are planning to use their own reproductive technologies, including clonal micro-propagation. Main stages are:

1. Propagation by cuttings, which are selected from parent trees of Fastigiata Uralica.
2. Clonal micro-propagation is the use of in-vitro techniques to obtain seedlings quickly and asexually, completely identical to the parent. Cuttings and cloning in the laboratory allow all seedlings to keep the form of the parent tree.
3. Growing in a greenhouse with a closed root system over three years up to a height of 15-20 cm. Further grown up to a height of 1-1.5 m in an open plantation.
4. The young trees are then put into pots to be sold wholesale and retail all year round through retail chains and garden centres.

The main stages are presented in Figure 7.

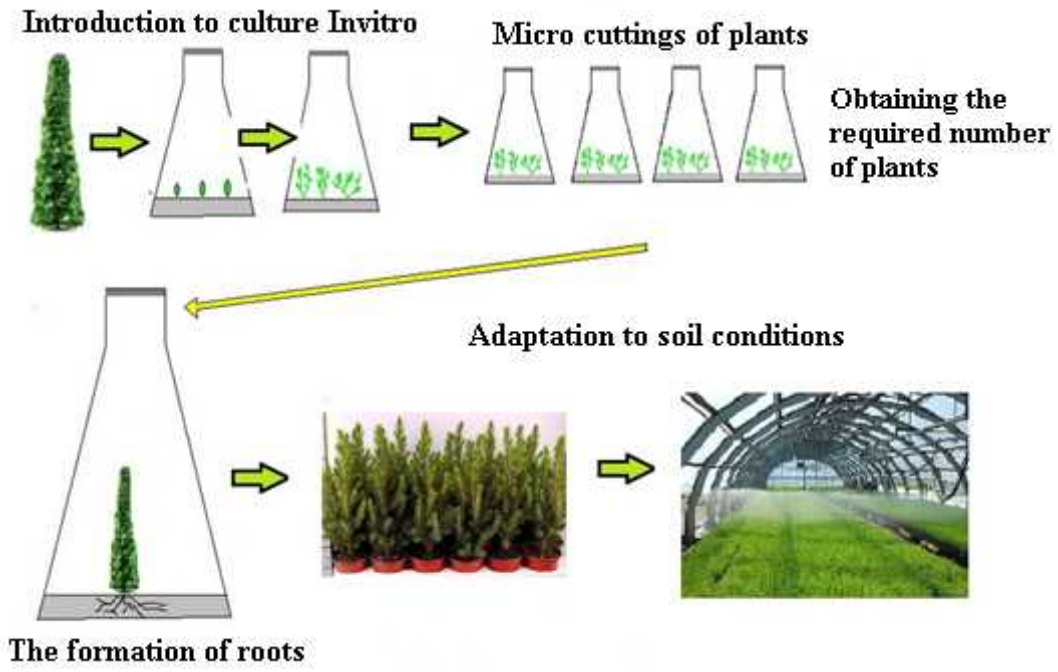


Figure 7. The Cultivation Process for 'Fastigiata Uralica'

The non-recurring costs in the project are estimated at about 14 million roubles:

- reconstruction of the greenhouse area of 750 m^2
- utilities
- equipment to transfer large trees
- preparation of the bedding soil
- automatic irrigation in the greenhouse and organization of ventilation
- office building and refurbishment of cloning laboratory.

Annual running costs in the project are estimated 12 million roubles including soil, fertilizers, planting pots and trays, personnel, and advertising. These costs cover cloning in the laboratory and cultivation of large-sized planting material on the plantation.

The planned annual production of three-year seedlings of spruce is of 130,000 units and of seven-year seedlings of 20,000 pieces. The payback period will be four years.

9. CONCLUSIONS

1. The ability to create aesthetically pleasing landscaping trees is expanding due to the high polymorphism of Norway spruce (Picea abies (L) H. Karst), but is limited by the climatic conditions.
2. The polymorphism of the Siberian spruce (Picea obovata Ledeb.) is significantly lower than that of the Norway spruce, which makes the discovery of a new decorative shape of the former very promising.
3. It is proposed to create a new brand for the recently discovered form of Siberian spruce with pyramidal, narrow columnar and crown shape, and drooping spiral branches. It is to be called 'Fastigiata Uralic' (P. obovata 'Fastigiata Uralica' Opletaev).
4. Analogues of this form of Siberian spruce are not to be found in any nursery in the world.
5. In the context of trees for landscaping Siberian spruce 'Fastigiata Uralica' is the most promising among versions of the genus Picea with these main advantages:
6. the Siberian spruce is hardier than European varieties and is undemanding to with regard to soil fertility. The compact, narrow-pyramidal crown shape 'Fastigiata Uralica' is ideal for the urban environment;

7. This new form of spruce can create the flavour of a Mediterranean landscape in the northern regions of Russia without using cypress.
8. The authors propose to start the processes for branding, industrial reproduction, cultivation and promotion of this new form of spruce.

Interest in the acquisition of domestic planting material from almost all consumer groups is increasing every year. The advantages are clear: hardiness, assurance of quality production, possibility of assortment planning and price stability (as domestic material does not depend on the exchange rate). We therefore, believe that 'Fastigiata Uralica' has high promise compared with other forms of spruce, and is of considerable interest for the market landscape design in Russia and abroad.

REFERENCES

1. Alexandrov M. Coniferous plants in your garden. - M .: JSC "FITON +", 2000. - 224 p.
2. Bolotov N.A. Theory, practice and forecast in the introduction of tree species on the territory of the former Soviet Union Doctoral Dissertation, St. Petersburg, 1992. 42 p.
3. Gusev A.V., Zalesov S.V., Sarsekov D.N. Methods of determining the prospects of introduction of woody plants. Socio-economic and environmental problems of forest complex within the concept of 2020: Proceedings of the VII Intern. Scientific and Technical Conference. Ekaterinburg: Ural State. Forestry Engineering University Press, 2009. pp 272-275.
4. Gusev A.V. The prospect of the use of exotic species of wood in landscaping Khanty-Mansiysk (middle taiga subzone of West Siberia). Dissertation candidate agricultural Sciences. - Ekaterinburg 2011.
5. Kozhevnikov A.P. Botanical gardens and arboretums of the world: a tutorial, Ural State Forestry Engineering University, Ekaterinburg, 2013. - 342 p.
6. Krekova J.A., Dancheva A.V., Zalesov S.V. Evaluation of decorative signs genus Picea Dieter. Northern Kazakhstan.Modern problems of science and education. - 2015. - № 1-1; URL: http://www.science-education.ru/ru/article/view?id=17204 (reference date: 01.02.2016)..
7. Kupriyanov A.N. Plant introduction: a tutorial. Kemerovo, Kuzbas University Press, 2004. 96p
8. Krussmann G. Conifer Handbook. - Berlin: Paul Parey. 1972. - 366 p.
9. Zalesov S.V., Platonov E.P., Gusev A.V. Promising exotic species of tree for planting in a middle taiga subzone of Western Siberia. Agricultural Gazette Urals. 2011. №4 (83). - Pp. 56-58.
10. Zalesov S.V., Dancheva A.V., Krekova J.A. A study of the prospects of exotic species of wood.: Ural State Forestry Engineering University Press, Ekaterinburg 2014. 13 p.

Authors' addresses:
Zalesov Sergey, Professor, PhD;
Faculty of forestry, the Institute of Forest and Natural Resource Management
Ural State Forest Engineering University (USFEU), Ekaterinburg, Russia
Corresponding author: Lotos_nk@inbox.ru
Opletaev Anton, PhD;
Faculty of forestry, the Institute of Forest and Natural Resource Management
Ural State Forest Engineering University (USFEU), Ekaterinburg, Russia
Corresponding author: Lotos_nk@inbox.ru
Natalia Pryadilina, PhD;
Faculty of economy of wood business, the Institute of Economics and Management,
Ural State Forest Engineering University (USFEU), Ekaterinburg, Russia
Corresponding author: Lotos_nk@inbox.ru
Damary Roy, Professor, PhD;
Graduate Institute of Business and Management INSAM, Switzerland, Geneva
Corresponding author: r.damary@insamgeneva.org

WoodEMA, i.a.

International Association for Economics and Management in Wood Processing and Furniture Manufacturing

PRODUCTION MANAGEMENT SYSTEM OF WOOD PROCESSING SME'S IN CROATIA

Dušak, M.; Jelačić, D.

ABSTRACT

Small and medium enterprises (SME's) make over 99 % of all industrial enterprises in Croatia. Very similar percentage of SME's can be found within Croatian wood processing and furniture manufacturing companies. The aim of this research was to establish the actual situation in production management systems of SME's in Croatian wood processing. Total of 30 small and medium companies from different areas of Croatia were surveyed trying to establish the advantages and problems in their production management systems, with the goal to propose the model to create better systems within SME's in Croatian wood processing branch, which could help companies to achieve better production and business results.
Key words: small and medium enterprises (SME's), wood processing, production management

1. INTRODUCTION

Small and medium enterprises (SME's) represent the very significant part of economy and industrial system of every single country. Croatia is no different in that segment. And in recent time numbers for SME's are increasing year by year. So, in the year 2014 there were over 100.800 small and medium enterprises, which represent 99,6 % of all industrial subjects in Croatia. In the year 2015 number of SME's incresed to over 104.100 enterprises (99,7 %). Out of those 99,7 % of all industrial subjects in Croatia, 98,5 % were micro and small enterprises, and 1,2 % were medium enterprises.

According to Croatian and European laws, micro enterprises are those which employ less than 10 employees and which income per year is less than 2 mil. €. Small enterprises are employing less than 50 persons with annual revenue of less than 10 mil. €. Medium enterprises have annual revenue of less than 50 mil. €, and less than 250 employees.

Small and medium entrprises participated in GDP with over 52 % in 2014, and over 53 % in 2015 (35 % was the share of small enterprises, and 18 % the share of medium enterprises). In 2014 some 68 % employees were empoleyed in SME's, and in 2015 SME's employees made 68,4 % of all employees in Croatia (50,9 % in small enterprises and 17,5% in medium enterprises).

In total Croatian export in year 2014 small and medium enterprises participated with 48 %, and in year 2015 that share of participation increased to 48,5 %, of which small enterprises participated with 25,2 % and medium enterprises participated with 23,3 %.

The situation and percentages of small and medium enterprises in Croatian wood processing and furniture manufacturing companies is similar to overall situation in Croatian industry. Since most of the wood processing and furniture manufacturing companies are situated in rural areas of Croatia, small and medium enterprises make a large percentage of all wood industry companies. Also, Croatian wood processing and furniture manufacturing companies are highly export oriented, so percentage of SME's export exceed the numbers given above presenting total Croatian export.

The aim of this research was to establish the actual situation in production management systems of SME's in Croatian wood processing and furniture manufacturing. We wanted to establish which parameters of management owners and managers in small and medium enterprises consider most important for their business and which of them they consider crucial for improving their business and production results in the near future. The questionnaire that was made for that purpose was trying to establish the adventages and problems in SME's production management systems, with the goal to propose the model to create better production and management systems within SME's in Croatian wood industry branch, which could help companies to achieve better production and business results.

2. RESEARCH RESULTS

The research was conducted with the survey in 30 small and medium companies in different regions of Croatia using questionnaire with 40 different questions with several statements of which manager in the company had tu choose one. Asked questions were statements about different production management parameters more or less important for each company production management system, according to manager's/owner's opinion.

Questionnaire was devided in two major parts. The first part, consisted of 11 questions, was dedicated to general information about the company, while the second part consisted of 29 questions directly connected to production management parameters. Those 29 questions gave several statements for each question with marks 1 to 5 (1 – not important at all, 5 – most important).

Questionnaire was spread among companies in different Croatian regions equaly, so all regions would participate in the research acordingly to their participation in number of companies all together, so 50 % of surveyed companies are situated in central Croatia, 20 % are situated in eastern Croatia, 20 % in mountain area of Croatia and 10 % in southern part of Croatia (seaside). Of surveyed companies 27 % were micro companies, 33 % were small companies and 30 % were medium enterprises. Production program of surveyed enterprises is shown on figure 1.

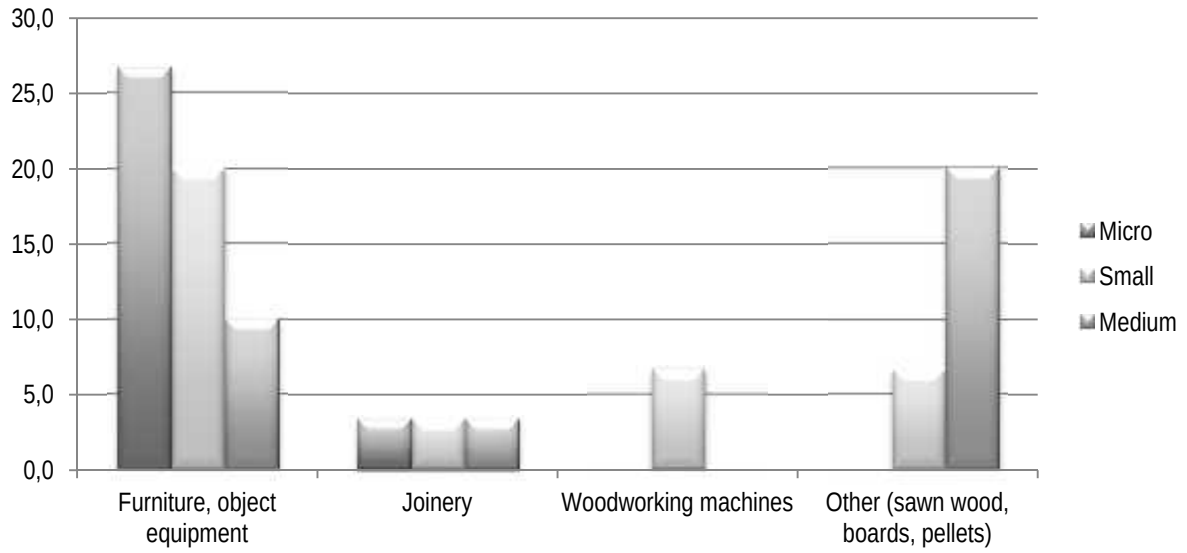


Figure 1. Production program in general in SME's

Two thirds (67 %) of companies manufacture products exclusively by the order of known customer, while 33 % of companies have their own shop, so they combine production by the order of known customer and production for the shop, for unknown customer.

Of surveyed enterprises, 26,7 % are small craft companies, usually family business, manufacturing individual (unique) products orderd by single customer who came to the company to order some furniture or some joinery by reputation (they gathered the information about the company from a friend or by chance). Other companies are some kind of legal entity. Most of the small craft companies are situated in central Croatia, while all surveyed companies in mountain area of Croatia are legal entities.

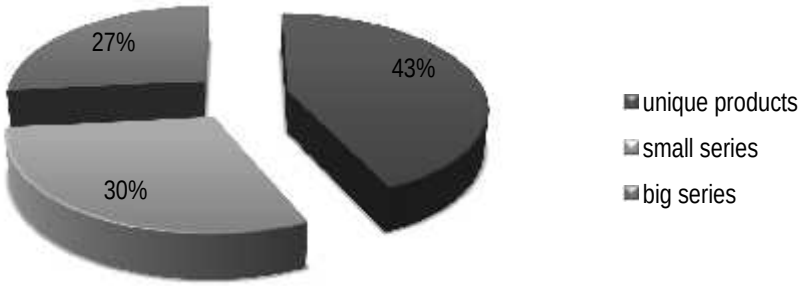


Figure 2. Production in SME's

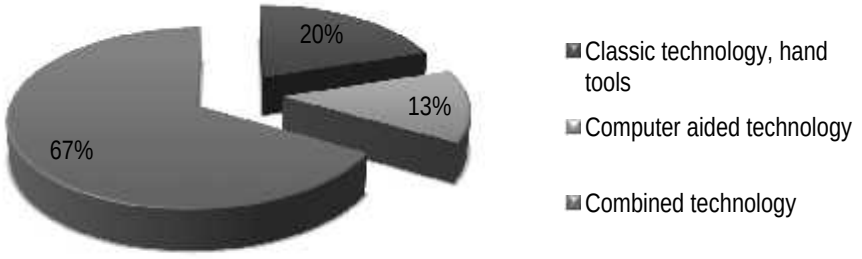


Figure 3. Equipment and tools in SME's

The second part of the questionnaire consisted of questions and statements which managers / owners had to mark according to their opinion of importance of the statement. Mark 1 means that given parameter is not importnant at all, and mark 5 means that given parameter is the most important one. Following graphs show what were the opinions of managers / owners to selected particular question.

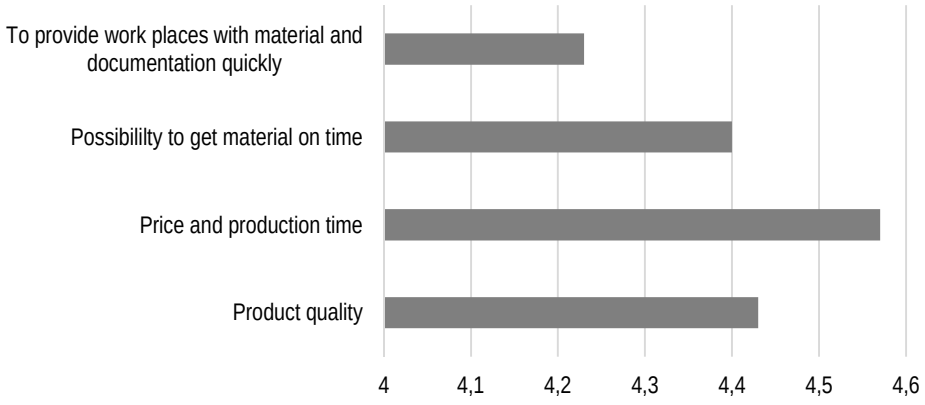


Figure 4. Importance of particular production input

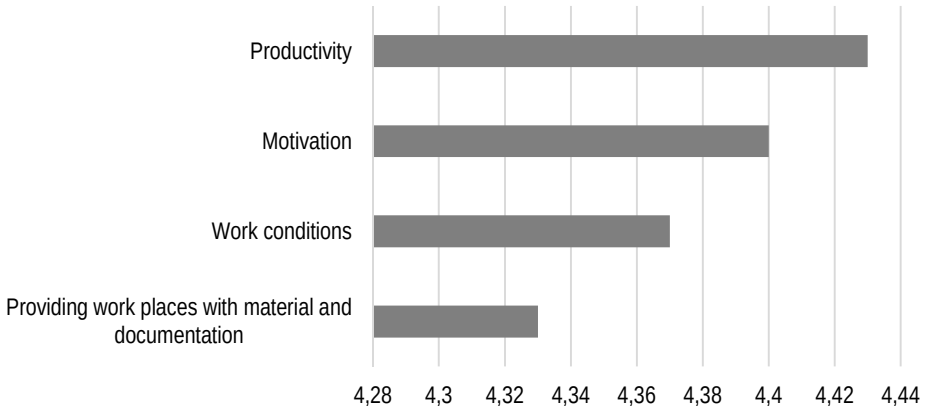


Figure 5. Criteria for production level

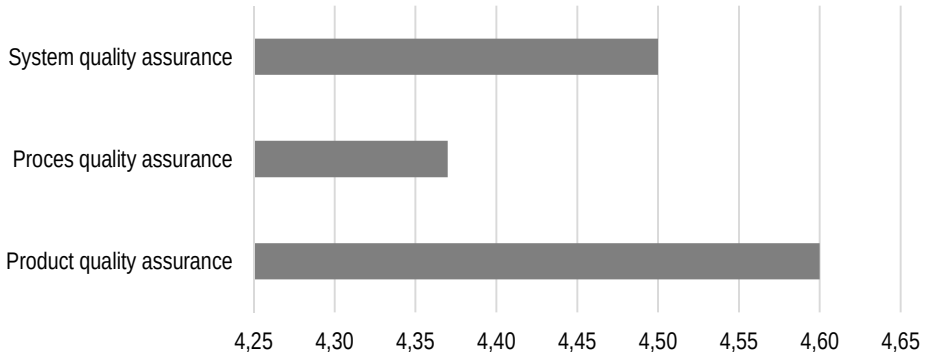


Figure 6. Importance of quality for SME's

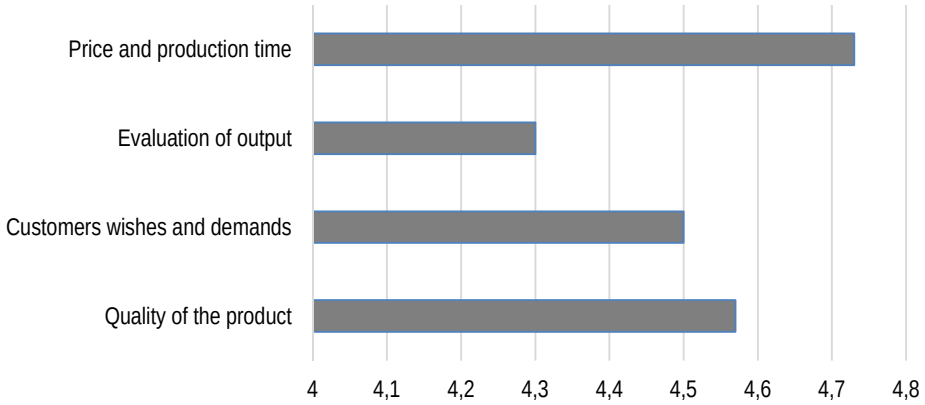


Figure 7. Importance of particular parameter for production output

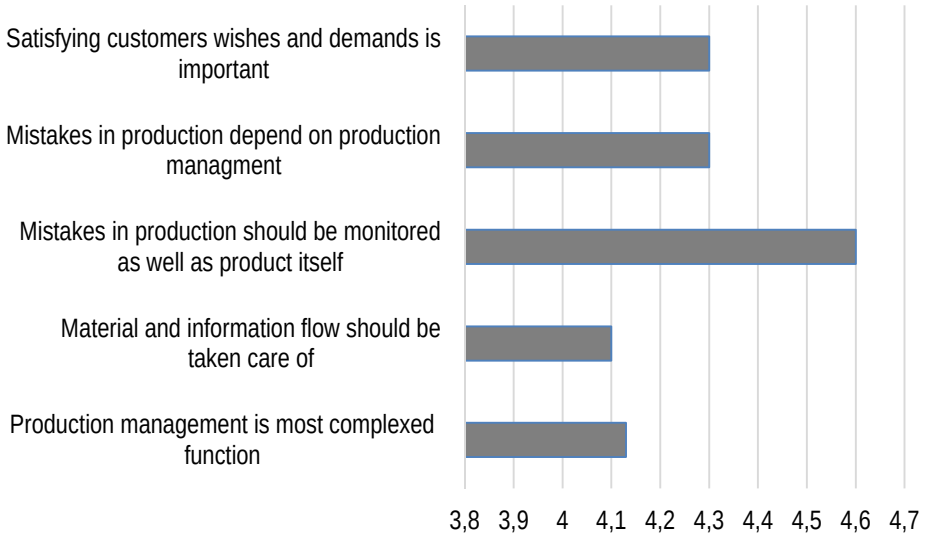


Figure 8. Statements on production management

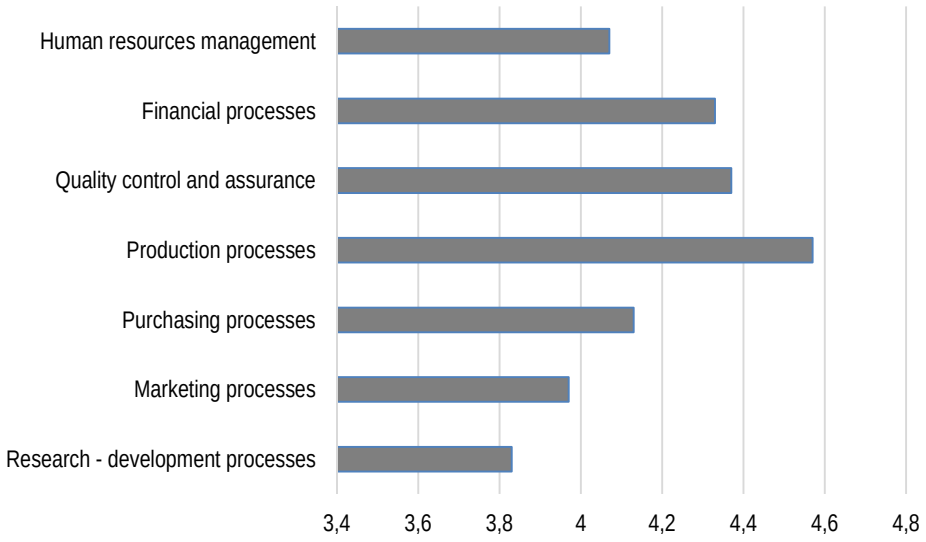


Figure 9. Importance of particular process for production in SME's

On figures given above, some of the answers with highest marks are presented. Some other questions with high marks were those regarding orientation to customers wishes and demands. Marks between 3.87 and 4.47 were given to answers regarding keeping the customers for future (4.47), matching customers demands in full (4.40), attracting new customers with production program (4.27), keeping track on the market with introducing new products (4.00) and new strategies in annual business plans (3.87).

Managers / owners gave high marks to statements on which criteria the think is most important to customers. So, they think the most important thing is high level of service (4.67), fast delivery of finished products (4.60), material availability (4.50), price (4.37), payment conditions (4.23), and supplier reputation (4.07).

3. CONCLUSION

Owners / managers of small and medium enterprises are aware of the fact that many parameters and conditions are important in managing the company. Because of the small number of employees (especially in small and micro companies), they are not able to meet all of those conditions and to implement all the parameters they would like to. So, they concentrate to those parameters the consider most important – product price, product quality, customer demands, fast delivery of finished product. Because of the same reason, lack of personell and doing all by themselves, they rarely have the oportunity to implement any kind of innovation or to implement some kind of quality assurance system.

This research is the basis for creating the model of supporting SME's with meeting conditions and parameters important to those companies to improve and develop.

REFERENCES (alphabetical order)

1. Baković, T.; Ledić-Purić, D. (2011): Uloga inovacija u poslovanju malih i srednjih poduzeća. Poslovna izvrsnost Zagreb, br. 1. JEL classification: 031.
2. Bistričić, A.; Agatić, A.; Kuzman, Z. (2011): The importance of small and medium-sized enterprises in the Croatian economy and in the European union states economies. Scientific Journal of Maritime Research. University of Rijeka, pp. 145-158.
3. Espinoza, O.; Smith, R. (2015): Business management practices for small to medium sized forest products firms. Virginia Polytechnic Institute and State University, Virginia State University, and the U.S. Department of Agriculture cooperating.
4. Grladinović, T.(1999): Upravljanje proizvodnim sustavima u preradi drva i proizvodnji namještaja. Sveučilište u Zagrebu, Šumarski fakultet.
5. Jelačić, D., Homakova, R., Pirc, A., Meloska, Ž. (2009): Seeking and implementation of innovation opportunities. Wood research, vol 54. No.4/2009. SDVU Bratislava, Slovakia, pp. 129-142.
6. Krajnović, A.; Lordanić, S. (2012): Strateški menadžment i korištenje instrumenata strateškog kontrolinga u malim i srednjim poduzećima. Pregledni rad. Oeconomica Jadertina, Vol.2 No 1. UKD 65.012.4:334.7.
7. Kurtović, G. (2013): Strategija rasta malog poduzeća. Predavanja (str. 1-15.)
8. Nanić, A. (2013): Small and medium enterprises as head of business of the European union. Profesional paper. University of Bihać.
9. Neira, C. O.; Lindman, M.T.; Fernandez, M.J. (2009): Innovation and performance in SME furniture industries. An international comparative case study. Mark. Intell. Plan. 27(2): pp. 216–232.
10. Nowduri, S. (2014): Management Information Systems Research for Small and Medium Enterprises: A Sustainability Perspective. International Journal of Software Engineering and Its Applications Vol.8, No.8. pp. 201-208
11. Okolić, M. (2007): Sistem za podršku razvoja malih i srednjih poduzeća. Diplomski rad. Fakultet poslovne ekonomije Banja Luka.
12. Skorup, A.; Krstić, M.; Bojković, R. (2012): Management information systems in small and medium enterprises. International Scientific Conference MANAGEMENT 2012.Mladenovac, Srbija.
13. Thompson, A.A. (2001): Strategic management: Concepts and cases. J Strickland III, 12 ed, Boston [etc.], McGraw-Hill: Irwin, cop.

Authors address:
Dušak, Marko[1]; Jelačić, Denis*[2]
[1] PhD student, Promid, d.o.o., Križevci, Croatia
[2] Prof. PhD., Department for production management, Faculty of Forestry, University of Zagreb, Zagreb, Croatia
*Corresponding author: djelacic@sumfak.hr

ELASTICITY MODULUS AS A FUNCTION OF SELECTED FACTORS

Svoboda, T.; Vokatý, V.; Záborský, V.; Gaffová, Z.

ABSTRACT

This paper is aimed to investigate the influence of the used wood species (European beech - Fagus Silvatica, quaking aspen - Populus Tremula L), used sample thicknesses (4, 6, 10 and 18 mm), wooden mass compaction degree (10% and 20%) and cyclic loading (0 or 10,000 cycles) on the elasticity modulus E as the feature to be evaluated. The outcome of the paper makes evident the influence of the following factors on the modulus values: wood species, compaction degree and lamella thickness. The number of cycles equal to 10,000 has a minimum influence on the elasticity modulus. The synergic effect of all monitored factors can be considered as an interaction statistically significant for the elasticity modulus values. From among the interaction of two factors, the following combinations are statistically significant: wood species*thickness and thickness*number of cycles. Statistically irrelevant are the following combinations: wood species*compaction, compaction*thickness, wood species*number of cycles and compaction*number of cycles. Three-factor analysis has shown the statistically significant interaction of wood species*compaction*thickness. The remaining three-factor interactions are not significant.
Key words: elasticity modulus, compaction, cyclic loading, European beech, quaking aspen

1. INTRODUCTION

The use of wood as a material from renewable sources, with low density and good mechanical property, has increased recently. The wood is used in furniture industry as well as in structural applications for both civic and agricultural buildings, mostly in form of bearers, columns, etc. (Christoforo, 2011). However, the obtaining of sufficient and suitable raw material is becoming more and more frequent issue for the wood processing industry. Despite the wood prices increase, it is necessary to search for options, which replace the wood species with high added value by the cheaper ones (Bekhta et al., 2016).

According to Sviták et al. (2014) more and more frequently new methods are tested and new procedsses applied more in order to increase the rigidity and strength of wood products, which will meet the demanding requirements for the improvement of structural and use properties. One of the processes changing wood mechanical properties is, e.g., the wood compaction. The compaction may improve the hardness and another mechanical properties of the wood (Kolmann & Côte, 1984; Bodig & Jane, 1993; Blomberg & Persson, 2004; Welzbacher et al., 2008); however, this method of wood processing was not usual due to its high cost and capacity requirements as well as technical problems with the resulting products (Blomberg, 2005). The wood compaction procedures were implemented in Germany as early as from 1930 under the trade name of Lignostone; in England it has been known as Jicwood and Jablo (Kultikova, 1999). Another two methods known as Compreg and Stayback were developed in the U.S. (Seborg, 1962). Compreg is compacted wood treated with resin. Unlike Compreg, Stayback is not a resin impregnated wood. For Stayback, the wood compaction with subsequent heat treatment is a usual method. In order to eliminate the elasticity, the wood had to be pressed under conditions allowing sufficient flow of lignine. The previous papers (Kunesh, 1961; Tabarsa & Chui, 1997; Seborg et al., 1962) indicate an important impact mainly of the force utilized, wood moisture and compression direction (longitudinal or transversal) on the wood compaction.

The wood is practically always exposed to cyclic loading. In practice, the cyclic loading of wooden structures is caused mainly by either wind or earthquake effects (Foliente, 2005) while the cyclic loading of furniture might be caused by the every-day use, etc. The wood resistance against low-frequency loading depends on both micro- and macroscopic structure of the wood (Boatright, 1983). Such loading can be simulated by the mean of wooden samples cyclic loading in lab environments. During the research, the

effect of pulses on wood mechanical properties can be monitored and evaluated (Kärenlampi et al., 2003; Gong & Smith, 2004; Salmén et al.,1985; Becker etal., 1977; Wright & Leppävuori).

Design of wooden structures as well as that of structures based on any different material, requires the knowledge of certain variables, including the elasticity modulus. These variables are obtained by the mean of either destructive or non-destructive experimental testing. The non-destructive testing is aimed to determine physical and mechanical properties of the structural element without altering its ability for the designed use (Ross et al., 1998, Wang et al 2008; Liang & Fu, 2007; Dong a Hai, 2011; Sales et al, 2011).

Quaking aspen wood (Populus Tremula L.) is one of the used in lesser extent. Longer fibers, lower density and pale, even white color are typical for the aspen. One of the ways of the aspen utilization increase consists in mechanical properties modification based on the wood density increase. The density increase might improve the wood resistance parameters, which are substantial for the wood use in production of bent-wood furniture (Gáborík et. al, 2011). The lab tests outcome for compacted and non-compacted as well as for cycled and non-cycled aspen wood has been compared with that of European beech (Fagus Silvatica L.).

The basic monitored factors were wood species, thickness and compaction degree. The monitored parameter for the evaluation of the lab testing was the elasticity modulus.

2. EXPERIMENTAL

2.1. Materials

The wood of European beech (Fagus Silvatica L.) and quaking aspen (Populus Tremula L.) was used for the test samples preparation. Lamellae with the following dimensions were made from the selected wood species: thicknesses of 4, 6, 10 and 18 mm, width of 35 mm and length of 600 mm. The elasticity moduli (E) before the cyclic loading (0 loading cycles) and after the cyclic loading (10,000 loading cycles) were found out on the test pieces made as mentioned above. The results obtained on these test pieces were compared with the test pieces, which underwent 10- and 20-% compaction. 10 test samples were used within each testing set. The compaction process for the individual testing sets is shown in Fig. 1.

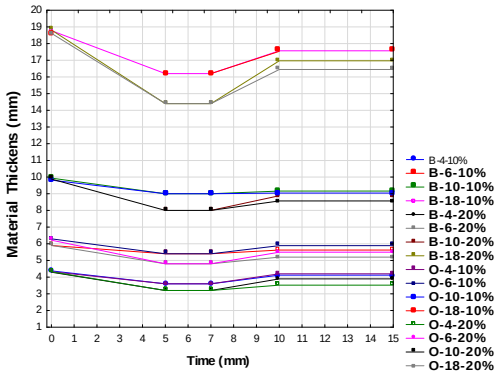


Fig. 1. The compaction process principle for the individual testing sets

2.2. Determination of Bending Strength and Elasticity Modulus

After the cyclic loading, the support span was adjusted to L1 = 20 x h (support span was changed in relation to thickness of materials combinations). The samples were bent in middle-length distance using a universal testing machine FPZ 100 (TIRA, Germany) in accordance with EN 310 (1993). The loading speed was set to 3 mm/min so that the test duration would not exceed 2 min. Maximum breaking forces of samples were measured using the datalogger ALMEMO 2690-8 (Ahlborn GmbH, Germany).

2.3. Evaluation and Calculation

To determine the influence of the individual factors on the bending characteristics, analysis of variance (ANOVA) and the Fischer F-test were performed using Statistica 12 (Statsoft Inc., USA) software.

The elasticity modulus was calculated in accordance with EN 310 (1993) and Eq. 1,

$$E_m = \frac{l_1^3 (F_2 - F_1)}{4bh^3 (a_2 - a_1)} \quad (1)$$

where Em is the elasticity modulus perpendicular to fibers in radial direction (MPa), l1 is the supports distance (mm), b is the sample width (mm), h is the sample thickness (mm), F2 – F1 is the loading increment in the proportional section of the load vs. deflection diagram, where F1 must represent approximately 10% and F2 is approximately 40% of the breaking load (N), and a2 – a1 is the deflection increment in the half of the sample length corresponding to the loading increment (F2 – F1).

The conversion of elasticity modulus to the moisture content of 12% was performed according to ISO 13061-4 (2014) and Eq. 2,

$$E_{12} = \frac{E_w}{1 - \sim (w - 12)} \quad (2)$$

where E12 is the elasticity modulus at the moisture content of 12% (MPa), Ew is the elasticity modulus at the moisture w (MPa), w is the moisture content of sample (%), and α is the moisture correction coefficient for the elasticity modulus equal to 0.01 for all wood species.

The wood density was determined before and after testing according to ISO 13061-2 (2014) and Eq. 3,

$$\circ_w = \frac{m_w}{a_w * b_w * l_w} = \frac{m_w}{V_w} \quad (3)$$

where ρw is the density of the sample at moisture content w (kg/m3); mw is the mass (weight) of the sample at moisture content w (kg); aw, bw, and lw are dimensions of the sample at moisture content w (m); and Vw is the volume of the sample at moisture content w (m3).

The moisture content of samples was determined and verified before and after testing. These calculations were carried out according to ISO 13061-1 (2014) and Eq. 4,

$$w = \frac{m_w - m_0}{m_0} * 100 \quad (4)$$

where w is the moisture content of the samples (%), mw is the mass (weight) of the sample at moisture content w (kg), and m0 is the mass (weight) of the oven-dry sample (kg). Drying to oven-dry state was also carried out according to ISO 13061-1 (2014).

2.4. Cyclic Bend Loading

The cyclic loading was carried out on a cycler machine with cyclic bending of the test pieces using single-axis loading. The following numbers of cycles were selected for testing: 0 and 10,000. During the preliminary experimental testing, the test pieces were loaded with static bending to determine the breaking strength and proportionality limit because the test pieces had to be loaded up to 90% of the proportionality limit.

Statistical Analysis

For the evaluation of results, a two-factor variance analysis evaluation of the effect of individual factors on the modulus of elasticity of solid wood and laminated wood was used. Based on the P-level value, it was determined whether the monitored factor affected the values of the modulus of elasticity. The achieved results were processed by the mean of diagrams showing a 95% confidence interval.

3. RESULTS AND DISCUSSION

Elasticity modulus average values and coefficient of variance are shown in Table 1.

Table 1. Average values of bending characteristics, density and coefficient of variance

Wood species	Material thickness (mm)	Degree of densification (%)	Number of cycles	Modulus of elasticity (MPa)	Density (Kg/m3)	Wood species	Material thickness (mm)	Degree of densification (%)	Number of cycles	Modulus of elasticity (MPa)	Density (Kg/m3)
Beech	**4**	**0**	**0**	14199 (14,3)	693 (4,6)	**Aspen**	**4**	**0**	**0**	1352 (14,8)	400 (4,1)
Beech	**4**	**0**	**10000**	13731 (18,4)	680 (9,5)	**Aspen**	**4**	**0**	**10000**	1626 (18,5)	416 (8,4)
Beech	**4**	**10**	**0**	15533 (15.8)	725 (8,6)	**Aspen**	**4**	**10**	**0**	1279 (14,8)	421 (9,3)
Beech	**4**	**10**	**10000**	17130 (3.3)	739 (6,6)	**Aspen**	**4**	**10**	**10000**	978 (12,6)	404 (3,6)
Beech	**4**	**20**	**0**	18105 (15,7)	784 (4,0)	**Aspen**	**4**	**20**	**0**	1445 (14,1)	488 (5,7)
Beech	**4**	**20**	**10000**	14097 (35,4)	766 (4,7)	**Aspen**	**4**	**20**	**10000**	1934 (18,9)	476 (14,1)
Beech	**6**	**0**	**0**	13270 (8,1)	665 (3,4)	**Aspen**	**6**	**0**	**0**	741 (5,9)	533 (8,7)
Beech	**6**	**0**	**10000**	13243 (10,0)	692 (4,4)	**Aspen**	**6**	**0**	**10000**	969 (7,2)	539 (4,4)
Beech	**6**	**10**	**0**	14476 (4,1)	703 (4,8)	**Aspen**	**6**	**10**	**0**	1418 (10,1)	557 (6,6)
Beech	**6**	**10**	**10000**	16082 (11,1)	749 (5,0)	**Aspen**	**6**	**10**	**10000**	1416 (9,6)	584 (7,9)
Beech	**6**	**20**	**0**	15325 (11,9)	751 (5,6)	**Aspen**	**6**	**20**	**0**	1520 (9,6)	620 (9,6)
Beech	**6**	**20**	**10000**	15726 (6,6)	750 (5,3)	**Aspen**	**6**	**20**	**10000**	1535 (10,3)	580 (6,5)
Beech	**10**	**0**	**0**	13820 (10,9)	694 (4,7)	**Aspen**	**10**	**0**	**0**	745 (5,4)	528 (4,2)
Beech	**10**	**0**	**10000**	13829 (11,1)	690 (5,8)	**Aspen**	**10**	**0**	**10000**	2240 (16,8)	536 (8,4)
Beech	**10**	**10**	**0**	15339 (8,0)	733 (3,7)	**Aspen**	**10**	**10**	**0**	857 (5,9)	564 (1,3)
Beech	**10**	**10**	**10000**	16265 (2,7)	719 (5,6)	**Aspen**	**10**	**10**	**10000**	2076 (14,0)	560 (5,8)
Beech	**10**	**20**	**0**	17050 (9,7)	788 (3,5)	**Aspen**	**10**	**20**	**0**	639 (4,4)	604 (1,8)
Beech	**10**	**20**	**10000**	15986 (7,7)	726 (2,5)	**Aspen**	**10**	**20**	**10000**	892 (6,4)	628 (13,9)
Beech	**18**	**0**	**0**	15123 (11,4)	735 (8,1)	**Aspen**	**18**	**0**	**0**	2344 (22)	529 (2,1)
Beech	**18**	**0**	**10000**	14232 (8,5)	698 (8,2)	**Aspen**	**18**	**0**	**10000**	1759 (14,7)	519 (12,7)
Beech	**18**	**10**	**0**	14841 (16,4)	744 (3,9)	**Aspen**	**18**	**10**	**0**	948 (7,3)	568 (4,8)
Beech	**18**	**10**	**10000**	15358 (16,1)	749 (4,6)	**Aspen**	**18**	**10**	**10000**	1293 (9,2)	581 (4,0)
Beech	**18**	**20**	**0**	15753 (11,3)	747 (6,8)	**Aspen**	**18**	**20**	**0**	928 (7,0)	589 (7,0)
Beech	**18**	**20**	**10000**	15834 (9,0)	757 (8,6)	**Aspen**	**18**	**20**	**10000**	870 (6,2)	594 (6,2)

As apparent from the results shown in Table 2, the following factors can be deemed as statistically significant: wood species, compaction degree and lamella thickness. The number of loading cycles has proven to be statistically insignificant.

Based on the significance level P values, the effect of synergic action of all four monitored factors can be deemed as statistically significant for the elasticity modulus values.

Based on the data shown in Table 2, it is evident that the statistically significant factors acting on the elasticity modulus are: wood species, compaction and thickness. Number of cycles has proven to be statistically insignificant.

From among the interaction of two factors, the following combinations are statistically significant: wood species*thickness and thickness*number of cycles. Statistically irrelevant are the following combinations: wood species*compaction, compaction*thickness, wood species*number of cycles and compaction*number of cycles.

Three-factor analysis has shown the statistically significant interaction of the factors wood species*compaction*thickness. The remaining three-factor interactions are not significant.

The combination of factors wood species*compaction*thickness*number of cycles is statistically significant. The statistically significant factors affecting the elasticity modulus are analyzed hereunder.

Table 2. Statistical evaluation of factors and their interaction on elasticity modulus

Monitored factor	Sum of squares	Degree of freedom	Variance	Fisher's F – Test	Significance level P
Intercept	4.631028E+10	1	4.631028E+10	15801.43	0.000001
1) Wood species	3.994980E+08	1	3.994980E+08	136.31	0.000001
2) Compaction degree	2.185998E+08	3	7.286659E+07	24.86	0.000001
3) Material thickness	1.506592E+08	2	7.532962E+07	25.70	0.000001
4) Number of cycles	2.903082E+04	1	2.903082E+04	0.01	0.920824
1*2*3*4	2.281075E+07	6	3.801791E+06	1.30	0.260245
Error	5.627070E+08	192	2.930766E+06		

As apparent from the measured values, wood species factor is statistically significant for the elasticity modulus values (Fig. 2). The average value was greater for beech samples (15,613 MPa) than for aspen samples (13,232 MPa).

The elasticity modulus value increases with the material compaction degree: for 10-% compaction by 8.2 % and for 20-% compaction by 14.7 % (Fig. 3).

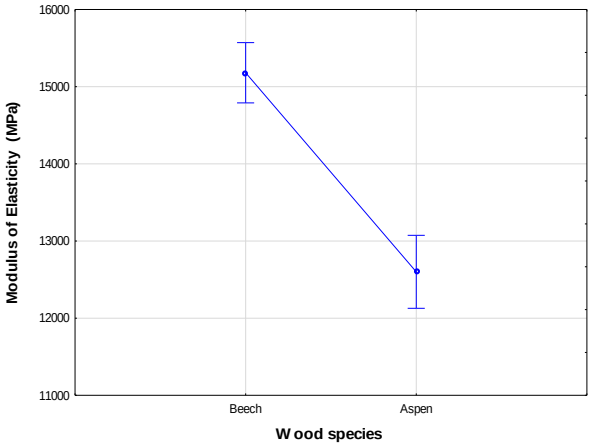


Fig. 2. The effect of the wood species on the elasticity modulus

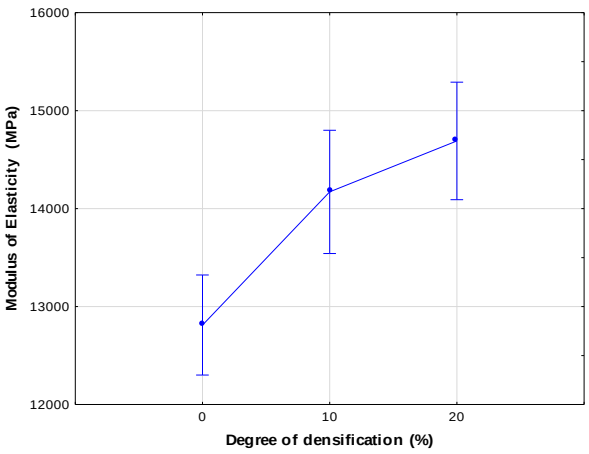


Fig. 3.The effect of the degree of compaction on the elasticity modulus

The highest values of the elasticity modulus were achieved with samples 6 mm thick (15,139 MPa). With increasing thickness the elasticity modulus decreases slightly, being for 10 mm equal to 14,971 MPa (by 1.1 %) and for 18 mm 14,673 MPa (by 3 %), however, the differences between these test pieces are not statistically significant (Fig. 4). The samples 4 mm thick with the value equal to 12,905 MPa, which is lesser by 14.8 % than for the samples 6 mm thick are the exception, and the difference between them and those 4 mm thick is statistically significant. Possible reason for lower elasticity modulus of 4-mm samples is that there is no tangential stress action yet at such small thickness and the aspen samples have significantly lower density. The effect of cyclic loading (Fig. 5) has proven to be statistically insignificant for the monitored parameter values.

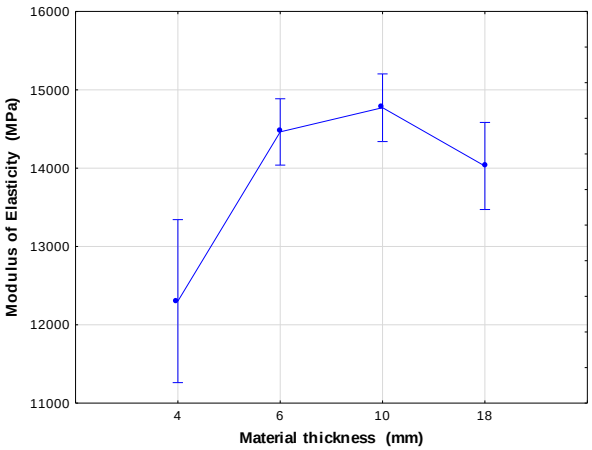


Fig. 4. The effect of the material thickness on the elasticity modulus

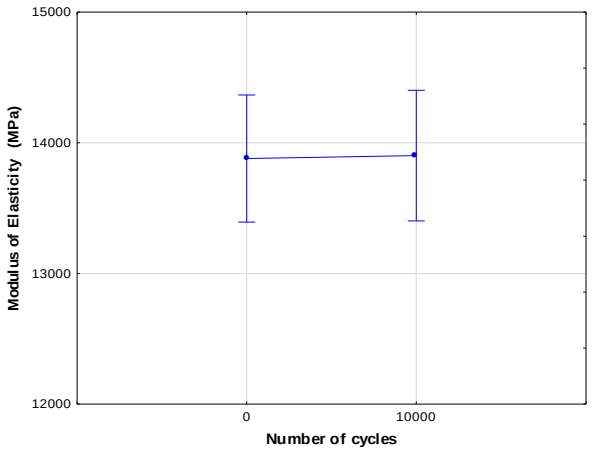


Fig. 5.The effect of the number of cycles on the elasticity modulus

While investigating the effect of all four monitored factors on the elasticity modulus value, this has proven to be statistically significant. Figs. 6 and 7 show the four-factor interaction on the elasticity modulus at 0 and 10,000 cycles.

For 4-mm non-compacted beech samples with 10,000 cycles, the elasticity modulus is higher by 3.3 % than for those with 0 cycles. For those 20-% compacted, the elasticity modulus is higher by 22.8 % while for those 10-% compacted by 10.3 %. For non-compacted and 10-% compacted aspen samples, the non-cycled ones achieved higher values. For those with 20-% compaction, the cycles samples achieved value higher by 2.3 %.

The 6 mm thick cycled and compacted (both 10- and 20-%) beech samples have higher elasticity modulus value while for the non-compacted ones there is almost no values difference between the cycled and non-cycled samples. The aspen samples achieved higher value of elasticity modulus for non-compacted and 10-% compacted samples exposed to 10,000 cycles while the 20-% compacted samples achieved higher elasticity modulus values for the non-cycled ones.

All cycled beech samples 10 mm thick (both 10- and 20-% compacted) have lower elasticity modulus values than the non-cycled ones. The greatest difference (30.5 %) is observed for the 10-% compacted samples. For aspen samples, there is no substantial difference between the cycled and non-cycled ones.

For thickness of 18 mm, it was found that the beech samples, except those non-compacted, have slightly increased elasticity modulus if cycled. For aspen samples, an increase in the cycled ones is also observed, although with degressive tendency.

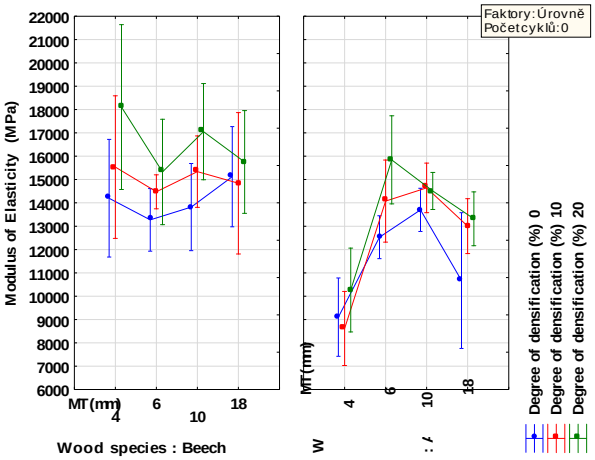


Fig. 6. Synergetic effect of all factors on the elasticity modulus

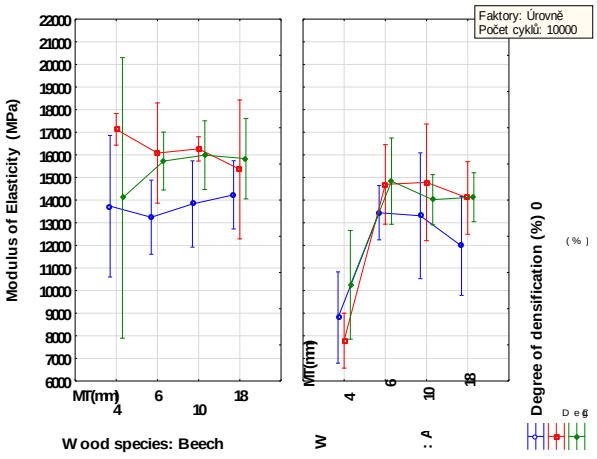


Fig. 7.Synergetic effect of all factors on the elasticity modulus

4. CONCLUSIONS

1. The wood elasticity modulus is affected by the wood species and thereby by the wood density. For beech (density of 723 kg/m^3), elasticity modulus values greater by 17.99 % were measured than for aspen (density of 538 kg/m^3).
2. Statistically significant increase of the monitored parameter values due to the wood compaction effect was found.
3. The elasticity modulus values do not change with the material thickness increase. Lower values of elasticity modulus were measured at material 4 mm thick; this is caused by tangential stresses with significantly lower effect at this thickness.
4. The cyclic loading has no statistically significant influence on the monitored parameter values.
5. The obtained results constitute priceless base for future design of layered materials conisting of both wood and non-wooden components with properties related to the specific use.

Acknowledgements: The authors are grateful for the support of the Internal Grant Agency (IGA) of the Faculty of Forestry and Wood Sciences, project No. B04/16 Principy tvorby lamelových materiálů.

REFERENCES

1. Becker, H., Höglund H., and Tistad G.: “Frequency and temperature in chiprefining”, PaperijaPuu, 3, pp. 123-130, 1977
2. Bekhta, P., Mamoňová M., Sedliačik J., a Novák I.; Anatomical study of short-term thermo-mechanically densified alder wood veneer with low moisture content. European Journal of Wood and Wood Products, ISSN 0018-3768. 2016
3. Boatright, S. W. J. and Garrett, G. G.: “Theeffectofmicroscructure and stress state on thefracturebehaviorofwood”, JournalofMaterials Science 18, pp. 2181-2199, 1983
4. Blomberg, J., B. Persson, Plasticdeformation in smallclearpiecesofScots pine (Pinussylvestris) duringdensificationwiththeCaLignumprocess, J WoodSci., 50, 307–314, 2004.
5. Blomberg, J., Elasticstrainatsemi-isostaticcompressionofScots pine (Pinussylvestris), J WoodSci. 51, 401–404, 2005.
6. Bodig, J., Jane, B.: MechanicsofWood and WoodComposites. KriegerPublishingCompany, New York, 1993.

7. Dong, X. H.; Hai, W. L. Comparative study on fourdifferentmethodsformeasuringthedynamicmodulusof elasticity of Acer mono wood. Advances in MaterialsResearch, New York, v. 160-162, p. 384-388, 2011.
8. Foliente. G. C.: "Design oftimberstructuressubjected to extremeloads", Progress in StructuralEngineering and Materials 1(3), pp. 236-244, 2005
9. Gáborík J., Dudas J., Kulík J., Rauina M.; " Propertiesofdensifiedlaminatedaspenwoodatbendloading", AnnalsofWarsaw University ofLifeSciences – SGGW Forestry and Wood Technology No 74, 2011: 69-73, 2011
10. Gong, M. and Smith, I.: "Effectofload type on failuremechanismsofspruce in compressionparallel to grain", Wood Science and Technology 37, pp. 435-445, 2004
11. Kärenlampi, P., Tynjälä, P.,andPasiStröm: "Molecularfatigue in steamedwood", International JournalofFatigue 25, pp. 489-497, 2003
12. Kolmann, F.D., Côte, W.A.: Principlesofwood science and technology. V.I, SpringerVerlag, Berlin, 1984.
13. Kultikova, E. V., Structural and PropertiesRelationshipsofDensifiedWood, Virginia Polytechnic Institute and State University, 1999.
14. Kunesh, R.H, Theinelasticbehaviourofwood: A newconceptforimproved panel formingprocess. ForestProductsJournal 11 (9): 395-406, 1961
15. Liang, S.; FU, F. Comparative study on threedynamicmodulusof elasticity and static modulusof elasticity forLodgepole pine lumber. JournalofForestryResearch, Colombo, v. 18, p. 309-312, 2007.
16. Ross. R. J.; Brashaw, B. K.; Pellerin, R. F. Nondestructiveevaluationofwood. ForestProductsJournal, Madison, v. 48, n. 1, p. 14-19, 1998.
17. Sales, A.; Candian, M.; Cardin, V. S. EvaluationofthemechanicalpropertiesofBrazilianlumber (Goupiaglabra) by nondestructivetechniques. Construction and BuildingMaterials, Guildford, v. 25, n. 3, p. 1450-1454, 2011.
18. Salmén, L., Tigerström, A. and Fellers, C.: "FatigueofWood – CharacterizationofMechanicalDefibration", Journalof Pulp and Paper Science, 11(3), pp. 68-73, 1985
19. Seborg, R.M., H. Tarkow, A.J. Stamm, Modifiedwoods. FPL, Report No. 2192, (revised), 30 pp. 1962.
20. Seborg, R.M., M.A. Millett, A.J. Stamm, Heatstabilizedcompressedwood (Staypak). FPL, Report No. 1580 (revised), 22 pp., 1962
21. Sviták, M., Gašparík, M., Penc, J. Heat resistance of glued finger joints in spruce wood constructions. Bioresources. 2014. S. 7529 – 7541. 9 (4). ISSN: 1930-2126
22. Tabarsa T, Y.H.Chui, Effectsof hot-pressing on propertiesofwhitespruce, ForestProductsJournal, 47(5):71-76, 1997.
23. Wang, S. Y.; CHen, J. H.; Tsai, M. J.; Lin, C. J.; Yang, T. H. Gradingofsoftwoodlumberusing non-destructivetechniques. JournalofMaterialsProcessing Technology, Amsterdam, v. 208, p. 149-158, 2008.
24. Welzbacher, C. R, J. Wehsener, A. O. Rapp, P. Haller, Thermo-mechanicaldensificationcombinedwiththermalmodificationofNorwayspruce (PiceaabiesKarst) inndustrialscale –Dimensional stability and durabilityaspect. Holz Roh Werkst, 66, 39–49, 2008.
25. Wright, K. and Leppävuori, E.K.M.: "Applicationoffracturemechanics to timber", Research notes 373, TechicalResearch Centre ofFinland, Espoo

Authors address:
Tomáš Svoboda*[1], Vojtěch Vokatý[2] , Vladimír Záborský[3], Zuzana Gaffová[4]
[1] Department of Wood Processing, Czech University of Life Sciences in Prague, Kamýcká 1176, Praha 6 - Suchdol, 16521 Czech Republic;
*Corresponding author: tomassvo@seznam.cz ,gaffmilan@gmail.com

BENDING STRENGTH AND PROPORTIONALITY LIMIT OF CYCLIC LOADING ON BEECH AND ASPEN SOLID WOOD

Vokatý, V.; Svoboda, T.; Kupčák, V.; Gaffová, Z.; Záborský, V.

ABSTRACT

This paper is aimed to investigate the influence of the used wood species (European beech - Fagus Silvatica, quaking aspen - Populus Tremula L), used sample thicknesses (4, 6, 10 and 18 mm), wooden mass compaction degree (10% and 20%) and cyclic loading (0 or 10,000 cycles) on the breaking strength (σp) and proportionality limit (σu) as the features to be evaluated. For the breaking strength, the statistically significant factors are the following: wood species, thickness, compaction and the combination wood species*thickness. The remaining factors and their interactions are not statistically significant. As evident from the measured values, the wood species factor is influencing the bend breaking strength, with the beech samples having an average bend breaking strength higher by 31.1% than the aspen samples. The bend breaking strength of the wood is increasing with its compaction degree. The breaking strength increases with the cyclic loading. Wood species, thickness, compaction and number of cycles are statistically significant factors influencing the proportionality limit. From among the combination of two factors, the following combinations are significant: wood species*thickness and wood species*compaction. Statistically irrelevant are the following combinations: thickness*compaction, wood species*number of cycles, thickness*number of cycles and compaction*number of cycles. Three-factor analysis has shown the statistically significant interaction of the factors wood species*thickness*compaction. The remaining three-factor interactions are not significant. The combination of all four factors is statistically significant.
Key words: breaking strength, proportionality limit, compaction, cyclic loading, European beech, quaking aspen

1.INTRODUCTION

Wood is a renewable material with such advantages as relatively low density, low costs and great aesthetics. At the same time, wood is environmentally friendly material. Due to all these advantages, wood is a contestee fully equivalent to another industrial materials such as concrete, glass, ceramics, iron, steel and another metals.

Wood compaction is one of the mechanical methods of adjustment of the wood basic properties. This can be made, for example, by the mean of rolling, which results in changes of wood mass volume and density (Kamke 2006). The compaction is used both in building and furniture industries (Gaff and Gašparík, 2015; Kurjatko et al. 2010; Blomberg a Persson 2007; Laine et al 2013).

The cyclic loading can be simulated in labs by the mean of cyclic loading of wooden samples. During the research, the effect of pulses on wood mechanical properties can be monitored and evaluated (Kärenlampi et al., 2003; Gong & Smith, 2004; Salmén et al.,1985; Becker et al., 1977; Wright & Leppävuori).

The research was aimed to investigate the influence of the used wood species (European beech - Fagus Silvatica, quaking aspen - Populus Tremula L), used sample thicknesses (4, 6, 10 and 18 mm), wooden mass compaction degree (10% and 20%) and cyclic loading (0 or 10,000 cycles) on the breaking strength (σp) and proportionality limit (σu) as the features to be evaluated. A logical followup to this activity is the economical evaluation based, e.g., on the production function. According to Bartuněk (1999), the production function describes the fabrication process course while differentiating process functions and economic functions in the production. The process production functions describe the specific production methods while the economic ones deal with the impacts of these methods on the production economy.

2.EXPERIMENTAL

2.1 Materials

The wood of European beech (Fagus Silvatica L.) and quaking aspen (Populus Tremula L.) was used for the test samples preparation. Lamellae with the following dimensions were made from the selected wood species: thicknesses of 4, 6, 10 and 18 mm, width of 35 mm and length of 600 mm. The breaking strength (σp) and proportionality limit (σu) before (number of loading cycles equal to 0) and after the cyclic loading (10,000 loading cycles) were found on the test pieces prepared this way.

The results obtained on these test pieces were compared with those measured on the test pieces subjected to 10- and 20-% compaction. 10 test samples were used within each testing set. See the classification of the monitored sets of test pieces in Table 1.

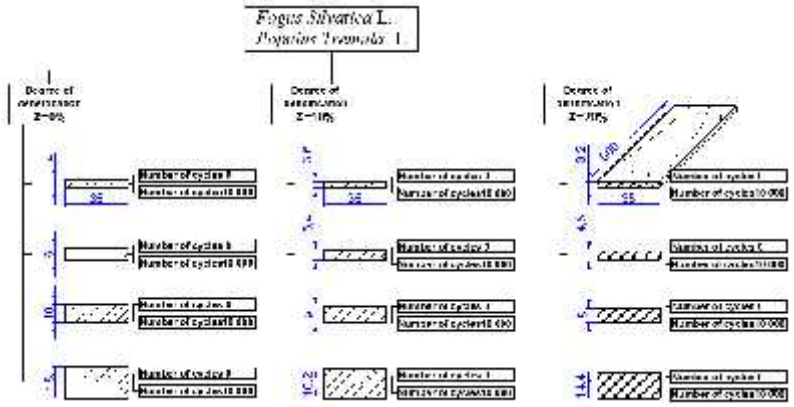


Fig. 1. Categorization of test pieces

2.2 Methods

Test Pieces Compaction

The test pieces to be compacted were pressed in a hydraulic press (RK Prüfsysteme MFL 1000, Germany). Table 1 shows the pressure used for the compaction of the individual sets of the test pieces.

Table 1. Pressure used for the individual groups of test pieces

Material thickness (mm)	Degree of densification 10%		Degree of densification 20%	
	Fagus (kN)	Populus (kN)	Fagus (kN)	Populus (kN)
4	3550	1080	3950	1500
6	2100	1850	3900	2100
10	3750	2150	4500	2500
18	3650	1720	3680	1800

Determination of bending strength and modulus of elasticity

After the cyclic loading, the support span was adjusted to L1 = 20 x h (support span was changed in relation to thickness of materials combinations). The samples were bent in middle-length distance (Fig. 2) using a universal testing machine FPZ 100 (TIRA, Germany) in accordance with EN 310 (1993). The loading speed was set to 3 mm/min so that the test duration would not exceed 2 min. Maximum breaking forces of samples were measured using the datalogger ALMEMO 2690-8 (Ahlborn GmbH, Germany).

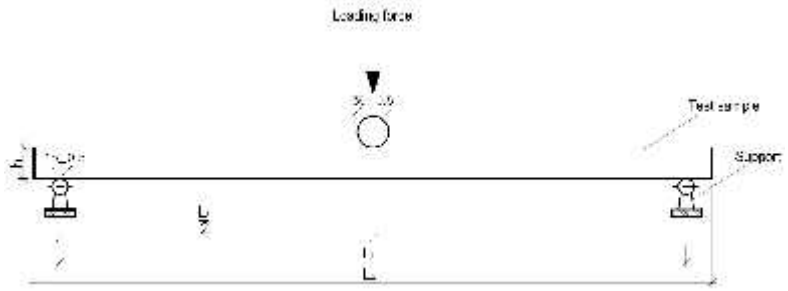


Fig. 2. Principle of the three-point bending test (EN 310)

2.3 Evaluation and Calculation

To determine the influence of the individual factors on the bending characteristics, analysis of variance (ANOVA) and the Fischer F-test were performed using Statistica 12 (Statsoft Inc., USA) software.The bending strength was calculated in accordance with EN 310 (1993) and Eq. 1,

$$\pm_{b} = \frac{3 * F_{\max} * l_{1}}{2 * b * h^{2}} \quad (1)$$

where σb is the (ultimate) bending strength of wood (MPa), Fmax is the maximum (breaking) force (N), l1 is the distance between supporting pins (mm), b is the width of the sample (mm), and h is the height (thickness) of the sample (mm). The bending strength values were converted to the moisture content of 12% in accordance with ISO 13061-3 (2014) and Eq. 2,

$$\pm_{12} = \pm_{w}[1 + \sim(w - 12)] \quad (2)$$

where σw is the wood bending strength at the moisture during the testing (MPa), σ12 is the wood bending strength at the moisture of 12% (MPa), w is the sample moisture during the testing (%), and α is the moisture correction coefficient, which was taken to be equal to 0.04 for all wood species.

The wood density was determined before and after testing according to ISO 13061-2 (2014) and Eq. 3,

$$\circ_{w} = \frac{m_{w}}{a_{w} * b_{w} * l_{w}} = \frac{m_{w}}{V_{w}} \quad (3)$$

where ρw is the density of the sample at moisture content w (kg/m3); mw is the mass (weight) of the sample at moisture content w (kg); aw, bw, and lw are dimensions of the sample at moisture content w (m); and Vw is the volume of the sample at moisture content w (m3).

The moisture content of samples was determined and verified before and after testing. These calculations were carried out according to ISO 13061-1 (2014) and Eq. 4,

$$w = \frac{m_{w} - m_{0}}{m_{0}} * 100 \quad (4)$$

where w is the moisture content of the samples (%), mw is the mass (weight) of the sample at moisture content w (kg), and m0 is the mass (weight) of the oven-dry sample (kg). Drying to oven-dry state was also carried out according to ISO 13061-1 (2014).

2.3.1. Cyclic bend loading

The cyclic loading was carried out on a cycler machine with cyclic bending of the test pieces using single-axis loading. The following numbers of cycles were selected for testing: 0 and 10,000. During the preliminary experimental testing, the test pieces were loaded with static bending to determine the breaking strength and proportionality limit because the test pieces had to be loaded up to 90% of the proportionality limit.

2.3.2. Statistical analysis

For the evaluation of results, a two-factor variance analysis evaluation of the effect of individual factors on the modulus of elasticity of solid wood and laminated wood was used. Based on the P-level value, it was determined whether the monitored factor affected the values of the modulus of elasticity. The achieved results were processed by the mean of diagrams showing a 95% confidence interval.

3 ENVIRONMENTAL AND ECONOMY-BASED APPROACH

As it results from the above mentioned, this research involves both environmental (renewable, environment-friendly raw material) and economic dimensions. The combination thereof can be evaluated on the base of (raw) material substitution, and, from the economy point of view, aside of the production function, also on the base of the scarcity. For example, according to Pearce (1990), the growing costs of the raw material logging are subsequently included in the market price; this results in the substitution of the primary raw materials by cheaper ones in the market as well as in more efficient utilization of the sources and in an increased demand for recycling. The basic production function expressing the relation among the production factors, is the following:

$$y = f(x_1, x_2, ..x_n) \tag{5}$$

where f is the production function, which is expressing the relation between the factors x1, x2, … xn and the final product y value. In order to define this function, the determination of the production factors based on both their statistical significance and the action quantification on the production volume is crucial. Within the production function, there is a substitution among the production factors: a quantity of factor xi can be substituted by a quantity of another factor xj without changing the quantity of the final product Q. Then the function is the production volume in the production function; usually expressed in value terms; and, e.g., the total sales ($\sum T$) for certain period are calculated as the multiplication product of the products quantity and their unit prices according to the following formula:

$$\sum T = \sum_{i,t} P_{it} * Q_{it} \tag{6}$$

where:

Pit = price of i^{th} product at time t,

i = 1, 2, 3, …, n,

t = 1, 2, 3, …, s,

Qit = quantity of i^{th} product sold in time t according to Kupčák (2006)

4 RESULTS AND DISCUSSION

The average values of the breaking strength and proportionality limit as well as the corresponding variance coefficients are shown in Table 2.

4.1Breaking Strength

As shown in Table 3, the statistically significant factors affecting the breaking strength are the wood species, thickness, compaction and wood species*thickness combination. This chapter deals with their more detailed evaluation. The remaining factors and their interactions are not statistically significant.

Table 3. Stacistical evaluation of Factors and their interaction on bending strength

Monitored factor	Sum of squares	Degree of freedom	Variance	Fisher's F - Test	Significance level P
Intercept	3621319	1	3621319	11663.57	0.000001
1) Wood species	126658	1	126658	407.94	0.000001
2) Degree of densification	10576	3	3525	11.35	0.000001
3) Material thickness	8831	2	4416	14.22	0.000002
4) Number of cycles	628	1	628	2.02	0.156650
1*2*3*4	2980	6	497	1.60	0.149220
Error	59612	192	310		

As evident from the measured values, the wood species factor affects the bending strength (Fig. 3). Bending strength average for the beech samples is 153 MPa, and for aspen samples 105 MPa, which gives the difference of 31.1 %.

The highest bending strength was found on the samples 6 mm thick (139 MPa); the bending strength decreases with increasing thickness, being 129 MPa (by 7 %) for 10 mm and 119 MPa (by 14 %) for 18 mm (Fig. 4). The saples 4 mm thick have their bending strength equal to 127 MPa, which is lesser by 8.5 % than for the samples 6 mm thick, however, their breaking stregth value is comparable with the samples 10 mm thick. Pssible reason for lower breaking strength of 4-mm samples is that there is no tangential stress action at such small thickness and the aspen samples have significantly lower density.

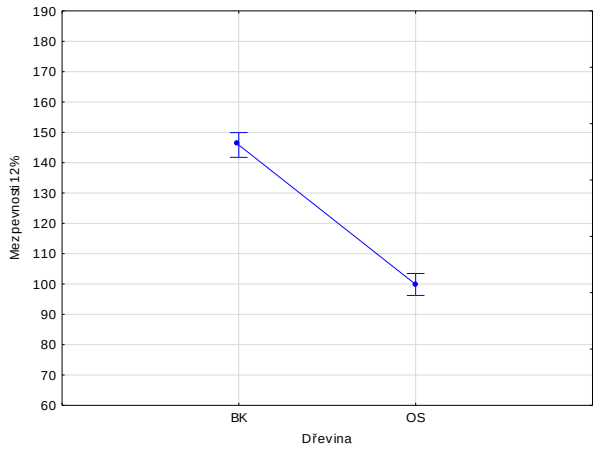


Fig. 3. The effect of the wood species on the bending strength

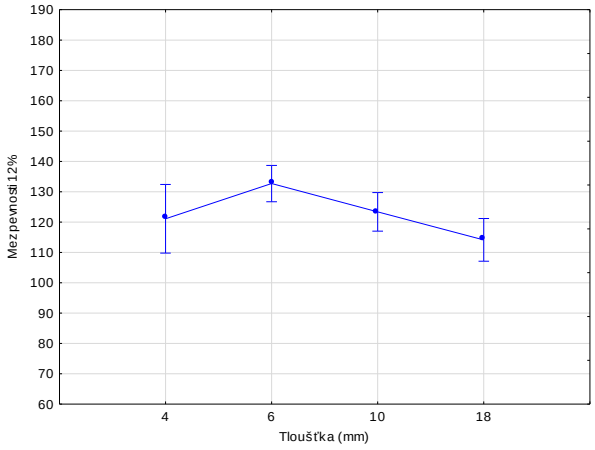


Fig. 4. The effect of material thickness on the bending strength

Table 2. Average values of bending characteristics, density and coefficient oo variance

Wood species	Material thickness (mm)	Degree of densification (%)	Number of cycles	Bending strength (MPa)	Proportionality limit (Mpa)	Density (Kg/m³)	Wood Species	Material thickness (mm)	Degree of densification (%)	Number of cycles	Bending strength (MPa)	Proportionality limit (Mpa)	Density (Kg/m³)
Beech	**4**	**0**	**0**	129(13,3)	80 (16,6)	693 (4,6)	**Aspen**	**4**	**0**	**0**	75 (7,7)	42 (20,4)	400 (4,1)
Beech	**4**	**0**	**10000**	132(16,4)	90 (26,0)	680 (9,5)	**Aspen**	**4**	**0**	**10000**	70 (12,6)	35 (11,4)	416 (8,4)
Beech	**4**	**10**	**0**	129(17,6)	76 (18,9)	725 (8,6)	**Aspen**	**4**	**10**	**0**	63 (13,0)	33 (16,8)	421 (9,3)
Beech	**4**	**10**	**10000**	143 (3,2)	102 (5,6)	739 (6,6)	**Aspen**	**4**	**10**	**10000**	58 (13,7)	33 (40,1)	404 (3,6)
Beech	**4**	**20**	**0**	145 (15,9)	83 (18,6)	784 (4,0)	**Aspen**	**4**	**20**	**0**	78 (12,6)	46 (22,7)	488 (5,7)
Beech	**4**	**20**	**10000**	130 (35,0)	82 (42,3)	766 (4,7)	**Aspen**	**4**	**20**	**10000**	76 (9,8)	67 (16,3)	476 (14,1)
Beech	**6**	**0**	**0**	116 (5,7)	66 (10,7)	665 (3,4)	**Aspen**	**6**	**0**	**0**	82 (14,1)	49 (14,0)	533 (8,7)
Beech	**6**	**0**	**10000**	114 (8,2)	55 (19,9)	692 (4,4)	**Aspen**	**6**	**0**	**10000**	98 (7,1)	60 (23,4)	539 (4,4)
Beech	**6**	**10**	**0**	128 (3,1)	70 (10,1)	703 (4,8)	**Aspen**	**6**	**10**	**0**	94 (10,2)	57 (19,8)	557 (6,6)
Beech	**6**	**10**	**10000**	141 (9,3)	80 (10,9)	749 (5,0)	**Aspen**	**6**	**10**	**10000**	109 (13,3)	70 (16,2)	584 (7,9)
Beech	**6**	**20**	**0**	129 (15,7)	65 (17,9)	751 (5,6)	**Aspen**	**6**	**20**	**0**	108 (17,8)	64 (14,1)	620 (9,6)
Beech	**6**	**20**	**10000**	139 (5,2)	74 (7,3)	750 (5,3)	**Aspen**	**6**	**20**	**10000**	103 (15,4)	67 (12,0)	580 (6,5)
Beech	**10**	**0**	**0**	115 (8,4)	58 (9,7)	694 (4,7)	**Aspen**	**10**	**0**	**0**	80 (11,5)	45 (7,5)	528 (4,2)
Beech	**10**	**0**	**10000**	119 (12,9)	73 (10,6)	690 (5,8)	**Aspen**	**10**	**0**	**10000**	80 (22,5)	47 (25,3)	536 (8,4)
Beech	**10**	**10**	**0**	126 (6,3)	66 (10,0)	733 (3,7)	**Aspen**	**10**	**10**	**0**	85 (3,9)	42 (8,4)	564 (1,3)
Beech	**10**	**10**	**10000**	113 (13,8)	63 (13,7)	719 (5,6)	**Aspen**	**10**	**10**	**10000**	88 (12,0)	52 (18,8)	560 (5,8)
Beech	**10**	**20**	**0**	134 (7,2)	64 (6,6)	788 (3,5)	**Aspen**	**10**	**20**	**0**	95 (8,6)	49 (13,3)	604 (1,8)
Beech	**10**	**20**	**10000**	131 (5,6)	74 (10,7)	726 (2,5)	**Aspen**	**10**	**20**	**10000**	99 (18,1)	58 (17,5)	628 (13,9)
Beech	**18**	**0**	**0**	114 (12,1)	53 (12,8)	735 (8,1)	**Aspen**	**18**	**0**	**0**	65 (25,5)	33 (23,4)	529 (2,1)
Beech	**18**	**0**	**10000**	111 (7,6)	55 (13,4)	698 (8,2)	**Aspen**	**18**	**0**	**10000**	76 (17,3)	39 (18,1)	519 (12,7)
Beech	**18**	**10**	**0**	113 (21,4)	54 (19,4)	744 (3,9)	**Aspen**	**18**	**10**	**0**	80 (17,0)	40 (13,1)	568 (4,8)
Beech	**18**	**10**	**10000**	118 (22,6)	56 (16,1)	749 (4,6)	**Aspen**	**18**	**10**	**10000**	90 (13,0)	43 (11,4)	581 (4,0)
Beech	**18**	**20**	**0**	117 (13,2)	53 (8,6)	747 (6,8)	**Aspen**	**18**	**20**	**0**	82 (10,9)	39 (14,1)	589 (7,0)
Beech	**18**	**20**	**10000**	123 (12,1)	59 (8,6)	757 (8,6)	**Aspen**	**18**	**20**	**10000**	84 (14,7)	44 (8,6)	594 (6,2)

As shown in Fig. 5, the wood bending strength increases with its compaction increase. Breaking strength of 120 MPa was measured for the non-compacted wood, 130 MPa for that one compacted to 10% and 135 MPa for that one compacted to 20%. Expressed in percentage, the breaking strength increased by 8.4% and 12.9% in comparison to non-compacted wood. If cycled, the breaking strength increases in statistically insignificant manner (Fig. 6).

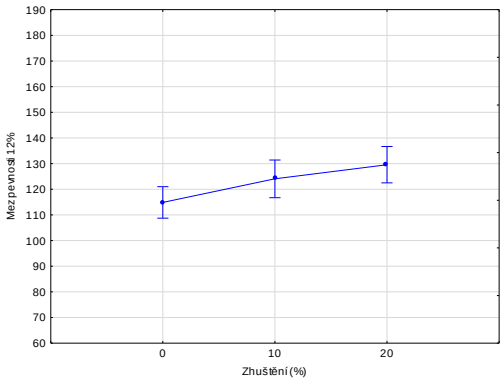


Fig. 5. The effect of degree of densify on the bending strength

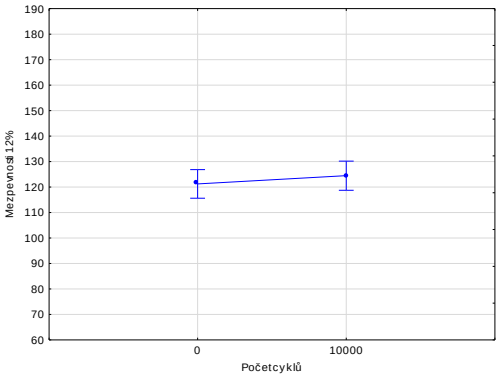


Fig. 6. The effect of number of cycles on the bending strength

Synergic effect of all monitored factors is shown in Fig. 7 and Fig. 8. The results proved that the most significant effect on the monitored parameter values is that of the wood species. Therefore, significant decrease of the values can be observed for aspen in all sets.

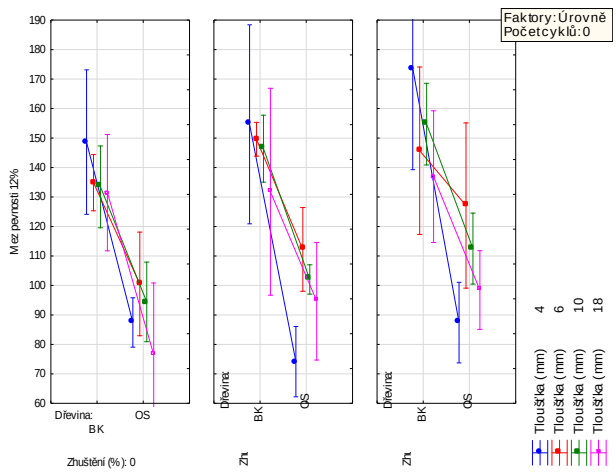


Fig. 7. Synergetic effect of all factors on the bending strength

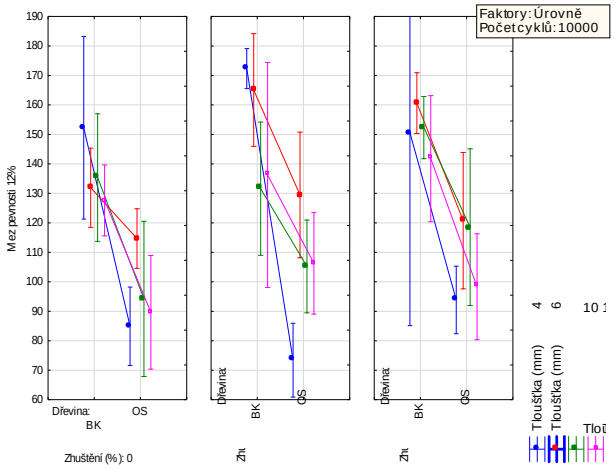


Fig. 8. Synergetic effect of all factors on the bending strength

4.2 Proportionality Limit

As shown in the results contained in Table 4, the statistically significant factors affecting the proportionality limit are: wood species, thickness, compaction and number of cycles. From among the combination of two factors, the following combinations are significant: wood species*thickness and wood species*compaction. Statistically irrelevant are the following combinations: thickness*compaction, wood species*number of cycles, thickness*number of cycles and compaction*number of cycles. Three-factor analysis has shown the statistically significant interaction of the factors wood species*thickness*compaction. The remaining three-factor interactions are not significant. The combination of all four factors is statistically significant. The text hereunder deals with the statistically significant factors and their interactions.

Table 4. Statistical evaluation of Factors and their interaction on proportionality limit

Monitored factor	Sum of squares	Degree of freedom	Variance	Fisher's F - Test	Significance level P
Intercept	1131205	1	1131205	7462.590	0.000001
1) Wood species	31434	1	31434	207.368	0.000001
2) Degree of densification	17211	3	5737	37.847	0.000001
3) Material thickness	2715	2	1357	8.954	0.000191
4) Number of cycles	3520	1	3520	23.219	0.000003
1*2*3*4	3940	6	657	4.332	0.000400
Error	29104	192	152		

As apparent from Fig. 9, the wood species factor is significant for the wood proportionality limit. An average proportionality limit of the wood is 84 MPa for beech samples and 60 MPa for aspen samples, i.e., lesser by 28.1 %.

The highest proportionality limit was found in samples 4 mm thick (79.9 MPa). Comparable values were found for samples 6 mm thick (79.7 MPa), where the difference is 0.3 %; however, there is smaller variance for the samples 6 mm thick. The decrease is more substantial for the remaining thicknesses: for samples 10 mm thick, 71 MPa (by 11.5 %) and those 18 mm thick, 58 MPa (by 27.5 %) (Fig. 10).

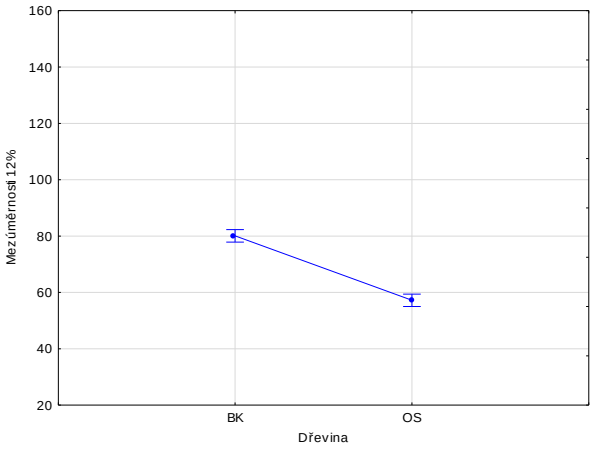


Fig. 9. The effect of wood species on the elastic proportionality limit

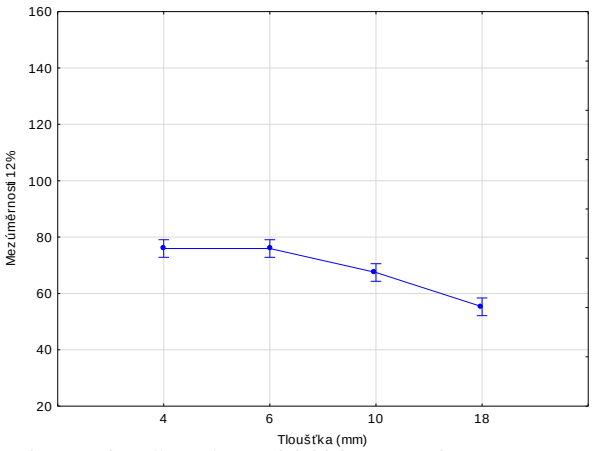


Fig. 10. The effect of material thickness on the proportionality limit

The compaction factor affects directly the proportionality limit, i.e., the latter increases with the compaction increase. The proportionality limit of the non-compacted samples is 67 MPa; for those with 10-% compaction, it is 73 MPa; and for those with 20-% compaction, it is 76 MPa, thus increasing the proportionality limit by 8.4 % and 12.8 % (Fig. 11).

The number of cycles has positive impact on the proportionality limit value of the researched samples (Fig. 12). An average value for the proportionality limit of non-cycled samples is 68 MPa while that of the samples undergoing cyclic loading is 76 MPa, which means a proportionality limit value increase by 11.9 %.

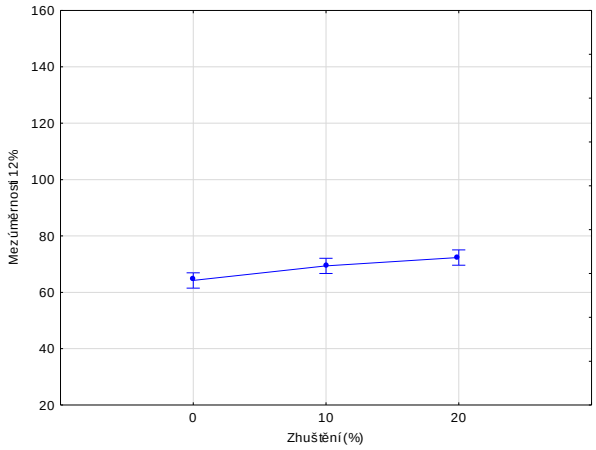


Fig. 11. The effect of compaction degree on the proportionality limit

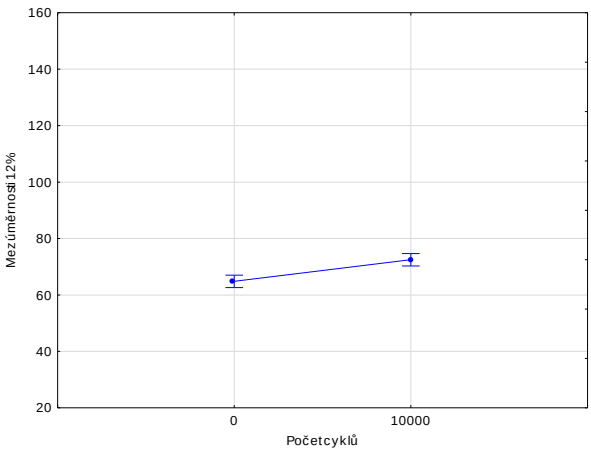


Fig. 12. The effect of number of cycles on the proportionality limit

While investigating the effect of all four monitored factors, their interaction was proven to be statistically significant for the proportionality limit value. Figs. 13 and 14 show the four-factor analysis of the proportionality limit at 0 and 10,000 cycles.

The difference between the proportionality limit of cycled and non-cycled samples of non-compacted wood is varying. The proportionality limit of cycled beech samples 4 mm thick is greater by 13.5 % than that one for non-cycled beech samples. On the other hand, the cycled aspen samples have the proportionality limit lower by 13.4 %. For beech samples 6 mm thick, the proportionality limit of the cycled ones is lower by 16.4 % whereas for the cycled aspen samples, the proportionality limit is greater by 15.5 %. For 10 mm thick samples, both beech and aspen cycled ones have higher proportionality limits (beech by 22.9 % and aspen by 4.1 %). Higher proportionality limit for cycled samples were measured at samples 18 mm thick for both beech (by 3.5 %) and aspen (by 19.2 %).

For samples with compaction degree of 10%, the values of the cycled ones were higher than of the non-cycled ones, except the beech samples 10 mm thick, whose proportionality limit value was lower by 4.2 %. The greatest difference can be noted at beech samples 4 mm thick, where the cycled samples have a proportionality limit greater by 35 %.

For the compaction degree of 20%, the proportionality limit value is increasing with the number of cycles, with the exception of beech samples 4 mm thick. The greatest increase is in aspen sample 4 mm thick, equal to 66.3 %. In the samples 18 mm thick, similar increases of the proportionality limit value was reported for both wood species.

With reference to the results of the factors significance (see Table 4), the comparison of the raw material substitution (beech and aspen) can be evaluated using the standard formula for calculation of the product manufacturing costs. Based on the currently valid price relations, it is possible to conclude within the category of direct material costs, that for the raw material (quality class III. A/B), the aspen wood oscillates around 30 – 40 % in comparison with the beech; for the lumber (joinery timber) while including the cutting and taking into account the yield rate, these relations increase to 40 – 50 %. The setup of this relation between the wood species remains unchanged for the last 5 years. Obviously, for exact comparison, the compaction process phase shall be taken into account; another factor could be the variable availability of the wood species within the logistic and distribution systems and conditions.

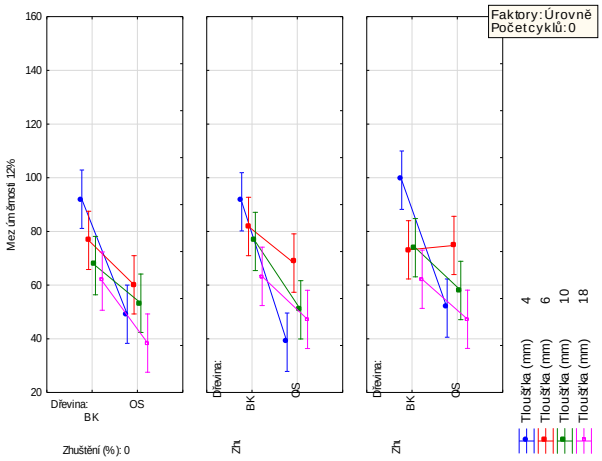


Fig. 13. Synergetic effect of all factors on the proportionality limit

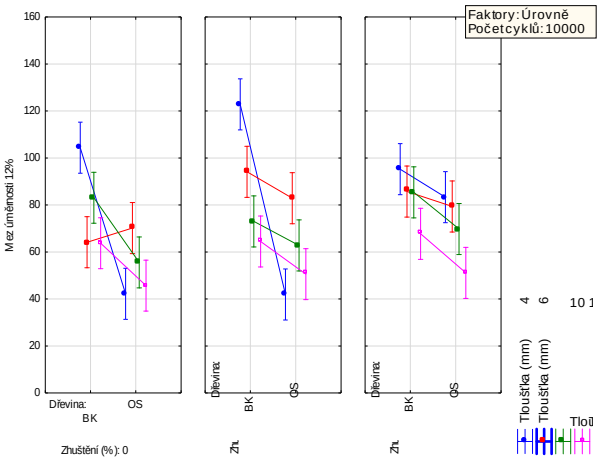


Fig. 14. Synergetic effect of all factors on the proportionality limit

5 CONCLUSIONS

The outcome hereof show the influence of selected factors (wood species, number of load cycles, material thickness and compaction degree) on the values of breaking strength and proportionality limit. Vysledky tvoria neodcenitelny zaklad poznatkov nevyhnutne potrebnych pri dalsom vyvoji vrstvovitych materialov na baze dreva a nedrevnych komponentov. The related research is laying in systematic manner the possibilities of the wood mass compaction process as well as the comparison of the wood species also in another relations, thus being in accordance with current strategic goals, such as, e.g., Plan of Action for Support of Self-Reliance of the Czech Republic in Raw Material Primary Sources by Secondary Raw Materials developed in 2015 by the Ministry of Industry and Trade. The research activities are beneficial also for the Forestry since the processing and utilization of aspen wood is very limited (except the pallet and packaging boards), and, first of all, with regard to the production times (aspen from 40 to 60 years, beech from 100 to 140 years). At last, but not at least, the benefit is coming also due to the possibilities (and the current trends) of cultivation of fast growing wood species within the industrial forestry plantations.

Acknowledgements: The authors are grateful for the support of the Internal Grant Agency (IGA) of the Faculty of Forestry and Wood Sciences, project No. B04/16 Principy tvorby lamelových materiálů.

REFERENCES

1. Bartuněk, J., Kupčák, V. Marktfahigkeit von Forst-und Holzproduktenaus der TschechischenRepublik auf Auslandsmarkten und die Assoziation in die EuropaischenWirtschaftsstrukturen. IUFRO - EuropaforumForstverwaltung- Staatsforstverwaltungen und Europäische Union, Working group S.6.12-02, Edenkoben 1999, Germany, s. 131 - 139
2. Becker, H., Höglund H., and Tistad G. (1977). “Frequency and temperature in chip refining”, PaperijaPuu, 3, pp. 123-130,
3. Blomberg, J., and Persson, B. (2007). “Swelling pressure of semi isostaticallydensifiedwoodunderdifferent mechanical esraints”, Wood Science and Technology 41(5), 401-415. DOI: 10.1007/s00226-006-0118-1
4. Gaff, M., and Gašparík, M. (2015). „Influence ofdensification on bendingstrenghtoflaminatedbeechwood“, BioResources 10(1), 1506-1518. DOI: 10.15376/biores.10.1.1506-1518
5. Gong, M. and Smith, I.(2004): “Effect of load type on failure mechanisms of spruce in compression parallel to grain”, Wood Science and Technology 37, pp. 435-445

6. Kamke. F.A. (2006). „Densifiedradiate pine forstructuralcomposites“, Maderas. Ciencia y Technología 8(2), 83-92. DOI: 10.4067/S0718-221X2006000200002
7. Kärenlampi, P., Tynjälä, P.,andPasiStröm (2003): “Molecular fatigue in steamed wood”, International Journal of Fatigue 25, pp. 489-497
8. Kupčák, V. Ekonomikalesníhohospodářství. 2. vyd. Brno: Mendelovazemědělská a lesnickáuniverzita v Brně, Edičnístředisko, 2006, 257 s., ISBN 80-7157-998-X.
9. Kurjatko, S., et al.: Parametrekvalitydrevaurčujúcejehofinálnepoužitie / Stanislav Kurjatko et al.; rec. Ivan Makovíny, ŠtefanŠteller. - Zvolen :TechnickáuniverzitavoZvolene, 2010. - 352 s. :obr., tab. - APVV-0282-06. - ISBN 978-80-228-2095-0
10. Laine, K., Rautkari, L., Hughes, M., and Kutnar, A. (2013). “Reducingthe set-recoveryofsurfacedensified solid Scots pine wood by hydrothermal post-treatment”,EuropeanJournalofWood and WoodProducts 71(1), 17-29. DOI: 10.1007/s00107-012-0647-2
11. Pearce, D. W.; Turner, R. K. 1990. Economics of Natural Resources and the Environment. Baltimore: The Johns Hopkins University Press, 1990. ISBN 0-8018-3986-6.
12. Salmén, L., Tigerström, A. and Fellers, C. (2985): “Fatigue of Wood – Characterization of Mechanical Defibration”, Journal of Pulp and Paper Science, 11(3), pp. 68-73
13. Wright, K. and Leppävuori, E.K.M.:“Application of fracture mechanics to timber”, Research notes 373, Techical Research Centre of Finland, Espoo
14. Wühlisch, G. (2009). EUFORGEN Technical Guidelines for genetic conservation and use of Eurasian aspen (Populustremula) Bioversity International, Rome, Italy. 6 pages.

Authors address:
Vojtěch Vokatý*[1], Tomáš Svoboda[2], Václav Kupčák[3], Zuzana Gaffová[4], Vladimír Záborský[5]
[1] Department of Wood Processing, Czech University of Life Sciences in Prague, Kamýcká 1176, Praha 6 - Suchdol, 16521 Czech Republic;
*Corresponding author: vokaty@centrum.cz,


Louisiana
Forest
Products
Development
Center

NEW TRENDS IN UPHOLSTERED FURNITURE

Tauber, J; Simek, M; Holus, Z; Svoboda, J

ABSTRACT

The objective of the paper is to demonstrate new trends in living room furniture, together with a design of an experimental construction of a lounge suite manufactured with current technology, using solid wood, composites and upholstery. The design of the construction refers to a current material possibilies, style and EU testing standards. The lounge suite presented in this paper resulted from a long shape, required properties of the furniture (safety, strength, durability and stability) and assembly that allowes safe transport. The aim was to produce a simple and functional product of an interesting shape which meets ergonomic and safety EU standard requirements for upholstered furniture.
Key words: upholstered furniture, design construction, strength, safety

1. CURRENT STATE

There are many homes that still use large wall units and heavy large lounge suites and armchairs, but this type of furnishing is not so frequent nowadays for most of the homes. People tend to follow trends of present days more often where there is lounge suite as number one. Lounge suites have many designs, technical performances, colours and materials and mostly style and shape altogether with finding a good spot determine how the athosphere of the living room looks. Wrong choice or placing may disrupt the disposition of the whole room. Such modul systems are being placed in many homes recently or classic corner sofas in shape of L and U. Classic sofa-beds or 2 smaller subtile sofas that can be placed in variable ways are being placed into smaller space. Colours are usually neutral such as creamy, beige and light grey or darker colours.

Putting the sofa into position for lying is a very demanded function nowadays. Sofa-beds are ideal for small houses and flats where the disposition does not allow creating a special room for guests. It is not that easy to find a good sofa-bed which is subtile and airy at the same time. The conversion system needs more complicated and massive construction so this type of seating will always look a bit more sturdy than other options of classic lounge suites available. So called „intelligent furniture“ is being used more and more, „inteligent lounge suites“ in our case. It is a type of variable furniture which contains hidden mechanisms that allows one to set particular parts from „talking“ to „resting“ positions. One can change depth and inclination of the seat, height of the backrest, height of head or lower back rest, shape and inclination of armrests and in some cases one can even change toughness of the seating by blowing more air inside when having this type of lounge suite. These types of lounge suites are more expensive and may contain also massage systems which are placed in various parts of the lounge and allows massage of various parts of the body. These hidden mechanisms and conversion mechanisms should be as simple as possible for manipulation and so there are more and more cases of furniture controlled by electric engines, with or without remote control. Simple variable lounge suites using new materials and technologies are being very topical and modern nowadays.

1.1. Examples of variable lounge suites

Living Sculpture lounge suite was made thanks to a project of world known Danish architect and designer Verner Panton and it is proving that alternative and variable seating is not only for nowadays but this type of unconventional furniture turned up even in the past. This lounge suite originated in 1970s reminds of a sculpture rather than lounge suite with its height of 3,5 metres. It is remarkable especially

with its colours and atypical organic shape which is great for various activities, not only sitting or lying. It may be useful especially for children who can use it as a domestic playground and which is good for climbing and crawling.

Figure 1. Living Sculpture sofa – Verner Panton

Variable lounge suite celled „Wave“ shows how to connect high functionality of the product with simple construction and modern design. „Wave“ offers, thanks to its organic curves and free pillows, several options how to sit or lie in very small space. It looks very ellegant thanks to its simplicity and curves and fits to almost every interior.

Figure 2. Wave sofa – Jan Armgardt

Another original leather lounge suite called DS 600 was created by a group of designers: Ueli Berger, Eleonoro Peduzzi Riva, Heinz Ulrich and Klaus Vogt. It is a seating compositional system from which one can create a lounge suite with variable lenght which can be shaped in various curves.

Figure 3. DS 600 – U. Berger, E. Peduzzi Riva, H. Ulrich a K. Vogt

Sofa "Yang" designed for Ligne Roset by French designer Francois Bauchet. Settee excels by its specific and very simple shape.

Figure 4. Yang sofa – Francois Bauchet

2. NEW DESIGN SOFAS

The newly designed sofa is inspired by the history and current status. Lounge suite design stands out for its particular shape. Its appearance is a combination of matter and at the same time subtility. Lightness of the object is achieved through a thin wooden legs. This lounge suite has several uses. It can be used in residential and public interiors. When the proposal was put great emphasis on ergonomics and comfortable seating. The final look of the new design is shown in the picture 5 and 6.

Figure 5. Designed sofa

Figure 6. Designed sofa – armrest detail view

3. TECHNICAL DESCRIPTION

Type of supporting frame construction determines its shape and type of covering which is based on the shape. Supporting frame consists of three assembling units (armrests [A], backrest [B], seat [C], put together by screws anf T-nuts M8 after furnishing with upholstery.

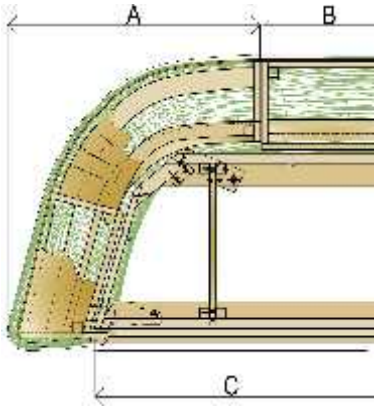


Figure 7. Assembling units and its shape

3.1. Material of the supporting frame

Rails and support blocks are made of hard solid wood (beech), other rails are made of hard coniferous wood (spruce). Vertical and shape units which are not suitable for solid wood because of size are made of 15 mm wide birch plywood , strained parts are doubled and have 30 mm width. Fillings are made of hard 3mm thick fibreboard and of 2,2 mm thick cardboard.

3.2. Construction of assembling units

3.2.1. Supporting frame of the armrests [A]

Connecting of parts is made by screws ø 4,5 mm or staples and supporting blocks, all connections are glued by PVAc on the whole surface. The fillings are glued and fastened on the peripheries by staples. Supporting frame

of the armrests is devided into two parts depending on the shape, front linear and back, which is round and spreads out behind the seat up to the backrest part. Uphostery is made from foam and fibre wadding.

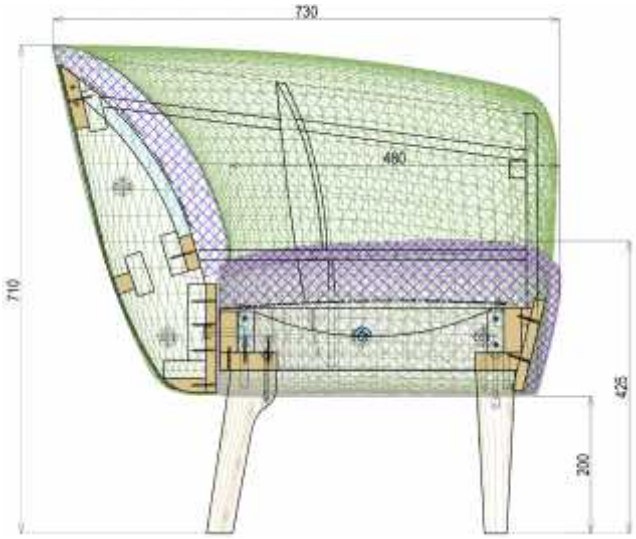


Figure 8. Sideview cut of the sofa set

3.2.2. Supporting frame of the backrest [B]

Similary to armrests, connecting of components is made by screws ø 4,5 mm or staples and support blocks, all connetion parts are glued with PVAc on the whole surface. The middle part is smaller on the front side than the side parts, to make it softer by inserting foam. Springing of the backrest surface is made by horizontal springing straps and 2 layers of foam with fibre wadding under covering, the back filling of backrest is firmed after being firmed to uphostered armrests. Covering is stiched invisibely.

3.2.3. Seat frame [C]

Seat frame is in shape of irregular hexagon, horrizontal rails and support blocks are made of hard wood (beech), back scew part is made of coniferous wood on the peripheries (spruce), side parts, crossbars and front seating skew part is made of 15 mm thick birch plywood. Connection of front rails and side parts is made thanks to wooden dowels ø 10 mm, which go through the whole thickness of the side parts where is screw in between, other connections are made by screws and support blocks. There are wooden scew legs fastened to lower rails by allen screws screwed to stop nuts and wooden pegs ø 10 mm glued to the leg. There are holes ø 12 mm made on the side and back part for screws, for connection with armrests and backrest. Springing of the seat is made by zig-zag sprigs, where is sandwich from polyuretan foam and fibre wadding under the covering.

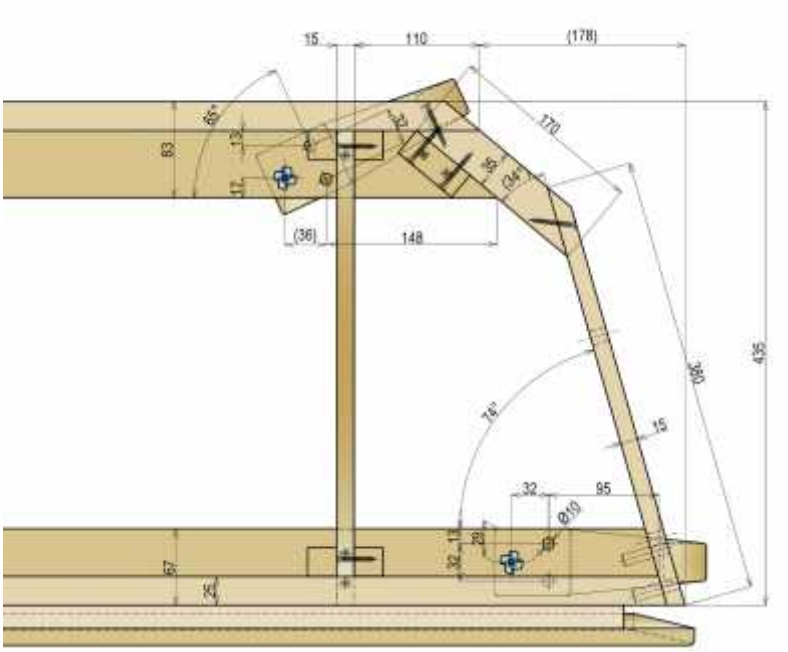


Figure 9. Ground plan view of the seat frame

4. REQUIREMENTS FOR STRENGHT AND SAFETY

A product should meet requirements stated in european standards EN 16139 Furniture - Strength, durability and safety - Requirements for non-domestic seating. If the requirements of these standards are met, it is probable that it will meet also requirements of domestic usage, EN 12520 Furniture -Strength, durability and safety - Requirements for domestic seating, because the requirements of EN 16139 are generally higher than EN 12520.

4.1. Requirements for safety, strength and durability

The product must be designed in such way that the risk of injuries of the chair user is avoided in these situations:

- sitting on the seat, in the middle and also out of the middle;
- movements to front, to the back and to the sides while sitting on the chair;
- bending over the armrests;
- pushing the armrests while standing up.

These requirements for safety, strenght and durability are met if during and after tests stated in standards EN 16139:

- there is no broken element, joint or component;
- there are no loose joints, that are supposed to be firm;
- there is no large deformation of any of the main parts of the construction;
- the chair is functioning after removing testing loading.

4.2. Stability

The stardard above states in general that furniture must not be overturned in these situations:

- while there is loading on the front edge of the seat surface in median plane;
- while loading the seat surface led over the front corner;
- while tilting to the side;
- while leaning on the backrest;
- while sitting on the front side of the seat.

Requirements for stability are met if the furniture is not overturned during tests demanded by the standards EN 16139.

The tests are being carried out due to EN 1728 Furniture - Seating - Test methods for the determination of strength and durability while using loadings stated in EN1613, level of test severity is in relation to applications and it determines 2 levels of usage:

1 – general usage (short term to several hours usage, light to heavy loadings, e. g. office buildings, presentation rooms, public buildings, cafés, restaurants, canteens, banks, bars);

2 – extreme usage (in such places where the furniture is occasionaly or repeatedly affected by extreme loadings because of specific type of usage or unappropriate usage, e.g. night clubs, police stations, traffic stations, sport changing rooms, prisons, barracks.

The stated product is built in a way to meet the requirements for general usage in public areas.

5. CONCLUSION

During the project, we have managed to create an overview of the most commonly used upholstered sets in homes, together with trends presentation. Based on the state of the art research the design proposal was developed for new seating product – lounge suite. The inner construction was made for this seating element. The construction is described in detail in the Technical Description section. There are also described important strength and safety requirements that must be fulfilled. The requirements are based on European standards for this type of furniture.

The presented product is built in a way to meet the requirements for general usage in public areas. Two experimantal prototypes will be build in order to verify all necessary EU standard reqirements.

Acknowledgements: This article was kindly supported from Internal Grant Agency of the Faculty of Forestry and Wood Technology, Mendel University in Brno – project ID LDF VT 2016018.

REFERENCES

1. EN 12520 (2016): Furniture - Strength, durability and safety - Requirements for domestic seating.
2. EN 16139 (2013): Furniture - Strength, durability and safety - Requirements for non-domestic seating.
3. EN 1728 (2013): Furniture - Seating - Test methods for the determination of strength and durability.

Authors address:
Tauber, Jiri*[1]; Simek, Milan[1]; Holous, Zdenek[1]; Svoboda, Jaroslav[1]
[1] Department of Furniture Design and Habitation, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
*Corresponding author: jiri.tauber@mendelu.cz


LSU
AgCenter
Research · Extension · Teaching

DEVELOPMENT OF THE WOODWORKING INDUSTRY PRODUCTION POTENTIAL IN POLAND – THE ECONOMICAL DIMENSION

Grzegorzewska, E.; Stasiak-Betlejewska R.

ABSTRACT

A wood is an important raw material used for the production of the Polish industry. In particular, it is used by the three industries that belong to the woodworking sector: the wood, the pulp and paper and the furniture industry. The production potential analysis of the woodworking market in Poland was presented in the paper. The results of the study are shown in the background of the manufacturing which is classified as the wood processing. Time scope of the research analysis concerns years 2005-2014. Primary source of the research material included reports published by the Central Statistical Office in Poland what is the Statistical Yearbook of Industry and the Production of major industries. In order to determine the production potential of the woodworking industry some economic production indicators have been selected such as: the production output, the average level of employment or the productivity growth measured by the production output per 1 employee. The production potential of the Polish woodworking industry is determined also by available assets. Therefore trends in gross value of fixed assets and its growth have been shown in the paper. Moreover, the development of the production volume of the woodworking industry major products in considered research period was presented by the authors.

Key words: woodworking industry, the production output, economic indicators

1. INTRODUCTION

The woodworking industry is an important part both of the world economy as Polish [Gejdoš and Potkany 2015, šupine 2014]. The basic raw material used in the manufacturing industry is a wood which affects its substantial links with the forestry. The woodworking industry with the pulp and paper and the furniture industry create the woodworking sector, classified according to the Polish Classification of Activities section C - Manufacturing [Grzegorzewska 2014]. In 2014 there were 69.8 thousand of enterprises in the woodworking industry whose the half represent the woodworking industry [Structural changes ... 2015].

Economic analysis of the woodworking industry highlights an exceptional potential of the Polish furniture industry production and export [Grzegorzewska, Stasiak-Betlejewska 2014 Grzegorzewska 2013]. However, the furniture industry is closely related to the woodworking industry, in particular the wooden board industry which provides wood-based materials for the furniture production [Ulewicz et all 2016]. Therefore, the development of the productive potential of the woodworking industry has an impact on the furniture industry which is strategic for the Polish economy.

The development potential of the company depends on the size and structure of resources as well as possible to attract external resources and the skills to use them [Skalik 2012].

On the other hand, the production capacity is a part of the company's potential production. It consists of potential material, financial potential and the potential of the work. The material potential is created by buildings and structures, machinery and equipment, and work items. On the other hand, the labour potential consists of human potential and working time [Nowosielski 2012]. The financial potential is associated with the available financial resources.

2. THE RESEARCH METHODOLOGY

The primary objective of the research was the productive potential development determination of the woodworking industry. Comparative analysis of the woodworking industry was carried on the background of the manufacturing industry and total industry. According to the Central Statistical Office of Poland (Polish name: GUS) methodology as part of PKD 2007 there was distinguished "Total industry" as an additional grouping which includes the following sections: section B (Mining and extraction - divisions 05-09), Section C (Manufacturing - divisions 10-33), Section D (Production and Electricity, gas, steam, hot water and air conditioning supply - Chapter 35), section E (water supply, sewerage, waste management and remediation activities - divisions 36-39). The study covered the years 2005-2014. In the research analysis there were applied following indicators: the sold production, the annual average employment level, the productivity growth as measured by the output per 1 employee. Therefore, the production capacity of enterprises also results from the available machine park, which is one of the production process resources, an analysis also included the gross value of fixed assets with dynamic changes. Moreover, the development of the woodworking industry production was also presented in the paper.

According to GUS methodology the sold production concerns the total activity of an economic entity, i.e., both industrial and non-industrial production. The sold production of industry includes [GUS 2015]:

- the value of finished products sold (regardless of whether or not payments due were received for them), semi-finished products and parts of the own production;
- the value of paid work and services rendered, i.e. both industrial and non-industrial;
- flat agent's fee in the case of concluding an agreement on commission terms and full agent's fee in the case of concluding an agency agreement;
- the value of products in the form of settlements in kind;
- products designated for increasing the value of own fixed assets.

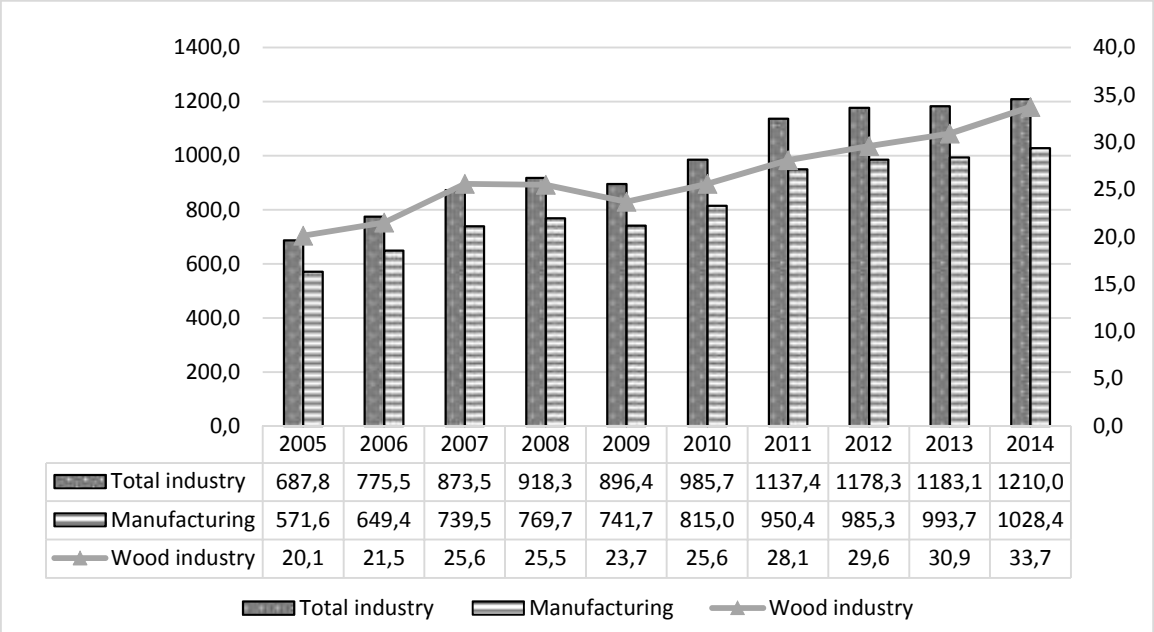
Gross value added accounts for the portion of output manufactured in industry that remains after deducting the value of intermediate consumption.

Data regarding the average paid employment in industry concern full- and part-time paid employees in terms of full-time paid employees.

Fixed assets include asset components completed and ready for usage with an expected period of utility exceeding 1 year. The gross value of fixed assets is the value equal to the outlays incurred on purchasing or manufacturing them, without deducting consumption value (depreciation) [GUS 2015].

3. RESEARCH FINDINGS AND DISCUSSION

The research conducted by the Central Statistical Office of Poland show that in 2005 the sold production of the woodworking industry amounted to 20.1 billion PLN, which means that its share of the manufacturing sector reached at level 3.5% (Figure 1). In the analyzed period (except 2009) the sold production of the manufacturing grew annually and in 2014 it amounted to 1,028.4 million PLN and it was 179.9% higher than in 2004. The highest growth in this area (115.4%) was observed in 2011. On the other hand, the sold production of the woodworking industry increased considerably by 67.7% and in 2014 it reached at 33.7 billion PLN. It should be noted that in 2008-2009 there was a decrease of the sold production value respectively by 0.4% and 7.1%. In contrast, the highest growth rate dynamics in this area was observed in 2007 and it amounted to 119.1%. In 2014 the sold production of industrial enterprises increased by 75.9% compared to the base year and it reached 1,210.0 billion PLN. The above analysis shows that the growth rate of the sold production in the woodworking industry and it was slightly lower than that recorded in the case of manufacturing and total industry.

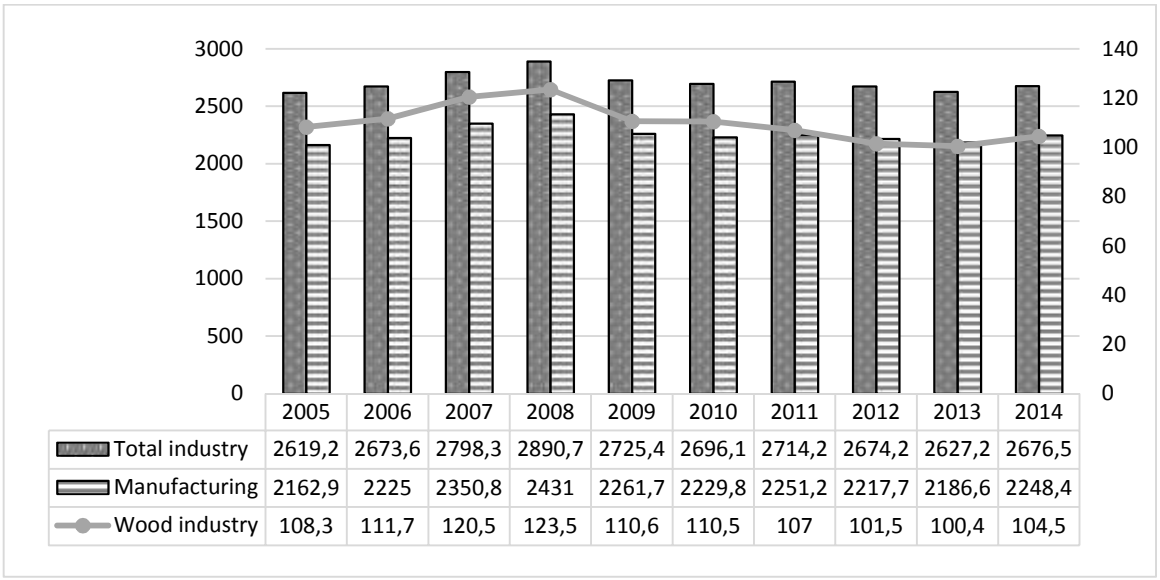


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total industry	687,8	775,5	873,5	918,3	896,4	985,7	1137,4	1178,3	1183,1	1210,0
Manufacturing	571,6	649,4	739,5	769,7	741,7	815,0	950,4	985,3	993,7	1028,4
Wood industry	20,1	21,5	25,6	25,5	23,7	25,6	28,1	29,6	30,9	33,7

Figure 1. The sold production of the woodworking industry on the background of the manufacturing and total industry in period 2005-2014 [billion PLN]

Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

In addition to the value of the sold production, an important information on the production potential of the woodworking industry is provided by the average of the employment level. As it results from the analysis of data presented in Figure 2, in the analyzed period, the average employment level in the woodworking industry was decreased by 3.5% (from 108.3 thousand to 104.5 thousand).



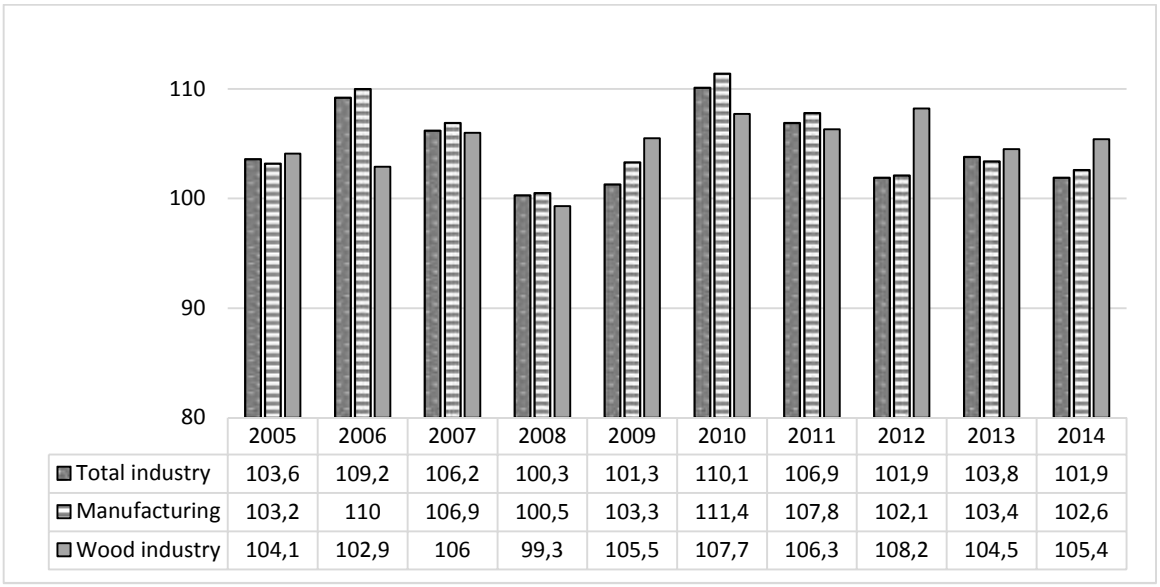
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total industry	2619,2	2673,6	2798,3	2890,7	2725,4	2696,1	2714,2	2674,2	2627,2	2676,5
Manufacturing	2162,9	2225	2350,8	2431	2261,7	2229,8	2251,2	2217,7	2186,6	2248,4
Wood industry	108,3	111,7	120,5	123,5	110,6	110,5	107	101,5	100,4	104,5

Figure 2. The average employment in the woodworking industry on the background of the manufacturing and total industry in the period 2005-2014 [thousand].

Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

The largest decrease of the employment level, more than 10%, was observed in 2009, while the largest increase (7.9%) took place in 2006. In the analysed period different tendencies in this area were observed in the manufacturing and in total industry. In the manufacturing, the employment level increased by 4.0% (from 2,162.9 thousand to 2,248.4 thousand). In 2014 in industrial enterprises total employment reached 2676.5 thousand and it is 2.2% more than in 2004.

Another indicator, which was analyzed in the assessment of the woodworking production potential development is the labour productivity. In a study conducted by the Central Statistical Office, this indicator is measured by output per 1 employee. Labour productivity growth in the timber industry was positive (Figure 3). The exception was the year 2008.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total industry	103,6	109,2	106,2	100,3	101,3	110,1	106,9	101,9	103,8	101,9
Manufacturing	103,2	110	106,9	100,5	103,3	111,4	107,8	102,1	103,4	102,6
Wood industry	104,1	102,9	106	99,3	105,5	107,7	106,3	108,2	104,5	105,4

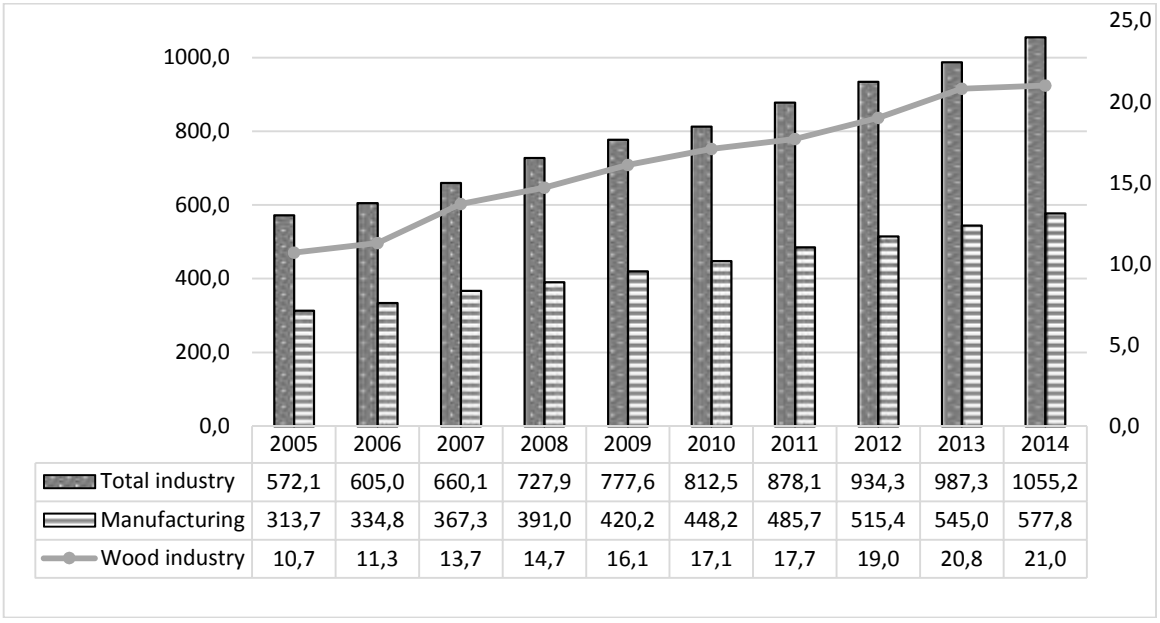
Figure 3. The dynamics of the labour productivity measured by output per 1 employee in the years 2005 to 2014 [%]

Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

The largest increase in the labour productivity in the woodworking industry was noted in 2010 and 2012 and it amounted to 107.7% and 108.2%. On the other hand, the manufacturing and total industry recorded an annual growth of the labour productivity measured by the value of the sold production per 1 employee. In 2006 and 2010 enterprises engaged in the woodworking processing achieved the best results in the industry. This efficiency indicator amounted to 110.0% and 111.4%. Industrial enterprises in total noted somewhat lower labour productivity. The highest value of this indicator was achieved again in these periods. It amounted to, respectively 109.2% and 110.1%.

The production potential of manufacturing enterprises also provides the gross value of fixed assets. This category belongs to fixed assets which dominate over the current assets in the woodworking industry enterprises. Fixed assets include buildings and structures, machines, equipment and means of transport. The higher the value of fixed assets in the company, the greater is usually its production capacity.

According to GUS research (Figure 4) in 2005 the value of the fixed assets in the industry amounted to 572.1 billion PLN. At the end of the analysed period, this ratio was 84.4% higher and amounted to 1,055.2 billion PLN. Positive trends in this area were also registered in the manufacturing. The gross value of fixed assets increased by 84.2% (from 313.7 billion PLN to 577.8 billion PLN). On the other hand, the timber industry recorded an even greater increase in this category of assets in 2014 and its value was higher by 96.3% and reached at 21.0 billion PLN.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total industry	572,1	605,0	660,1	727,9	777,6	812,5	878,1	934,3	987,3	1055,2
Manufacturing	313,7	334,8	367,3	391,0	420,2	448,2	485,7	515,4	545,0	577,8
Wood industry	10,7	11,3	13,7	14,7	16,1	17,1	17,7	19,0	20,8	21,0

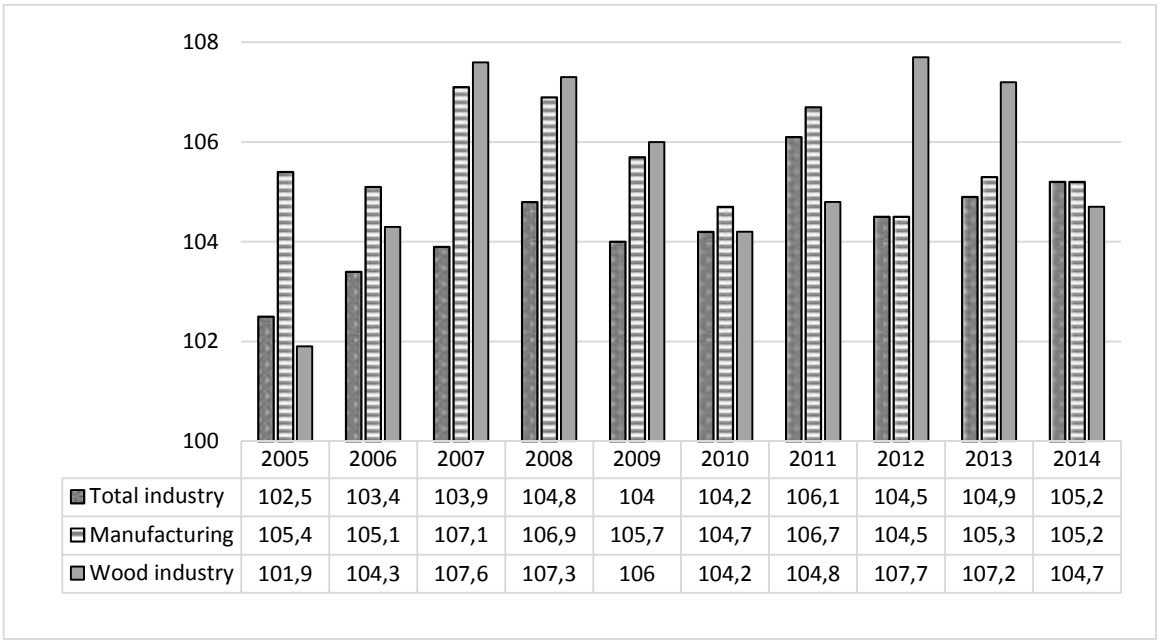
Figure 4. Gross value of fixed assets in the woodworking industry on the background of the manufacturing and total industry in the period 2005-2014 [billion PLN]

Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

In 2005-2006, the highest growth rate of the gross value of fixed assets was observed in the manufacturing. It amounted to, respectively 105.4% and 105.1%. On the other hand, in 2007-2009 the woodworking industry enterprises were characterized by the largest increase in the category of fixed assets (107.6% and 107.3%). A similar situation was observed in this group in 2012-2013. The dynamics of the gross value of fixed assets amounted then to 107.7% and 107.2%. As a rule, the gross value of fixed assets grew at industrial enterprises in total. The exception of the years 2005, 2011 and 2014, when the woodworking industry took the weakest position in this respect among the analyzed groups.

The development of the production potential is also confirmed by the production scale increase, i.e. the volume of the produced wooden products in the analysed period. Table 1 shows trends in the production of major products of the woodworking industry, which are presented in the report of GUS titled "Production of major industrial products."

In the years 2005-2014 the scale of the sawn timber production increased by 40.4% (from 3360 dam^3 to 4719 dam^3), whereby it should be noted that the volume of the sawn softwood production increased by 50.3%. The highest growth rate (22.5%) was observed in 2007. In the analyzed period the production of plywood consisting of wooden sheets has doubled. There was also noted the chipboard production increase. This volume increased by 869 dam^3. In 2014 there was produced 4809 dam^3 of this product. The largest increase in the volume of this product was recorded in 2006-2007 and it amounted to 13.9% and 19%. It is worth noting that in the analyzed period a wooden fibreboard and wood-based materials production was increase by nearly half. The highest growth rate (14.3%) was recorded in 2013. Negative trends in the woodworking industry manufacturing were recorded only in the case of veneers. In the years 2005-2014 the veneers production was reduced more than doubled from 54.3 by nearly half to 25.2 km^2.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total industry	102,5	103,4	103,9	104,8	104	104,2	106,1	104,5	104,9	105,2
Manufacturing	105,4	105,1	107,1	106,9	105,7	104,7	106,7	104,5	105,3	105,2
Wood industry	101,9	104,3	107,6	107,3	106	104,2	104,8	107,7	107,2	104,7

Figure 5. The dynamics of the gross value of fixed assets in the woodworking industry on the background of the manufacturing and total industry in the period 2005-2014 [%]

Source: own study based on Statistical Yearbook of the Industry for the years 2006-2015, the Central Statistical Office of Poland.

Table 1. Production of the woodworking industry major products in the period 2005-2014

Specification	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Saw timber in dam^3 , Including:	3360	3607	4417	3786	3850	4220	4422	4249	4321	4719
softwood lumber	2813	3018	3770	3299	3383	3765	3946	3796	3874	4227
hardwood timber	547	589	647	487	468	455	476	453	447	492
Plywood consisting solely of wooden sheets in dam^3	104	108	122	118	82,4	123	175	174	184	208
Chipboards & similar boards of wood or wood-based materials in dam^3	3940	4486	5339	5088	4704	4684	4918	4879	4786	4809
Fibreboard of wood or wood-based materials in km^2	416	446	481	452	466	501	492	502	574	620
Veneers in km^2	54,3	62,8	59,4	55,7	43,7	34,8	26,8	26,8	25,1	25,2

Source: own study based on GUS reports: "Production of major industrial products" for the years 2006-2015

4. CONCLUSION

GUS studies show that in 2014 the sold production of the woodworking industry reached at 33.7 billion PLN and it was higher by 67.7% than 10 years earlier. It is true that the growth rate of the sold

production was slightly lower than that recorded in the case of the manufacturing and total industry, however it obtained a satisfactory level. In the analyzed period, the average employment in the woodworking industry decreased by 3.5% (from 108.3 thousand to 104.5 thousand).

The largest, more than ten percent decrease was observed in 2009 while the largest increase (7.9%) took place in 2006. Despite the employment level decrease there was observed a positive trend in the area of the labour productivity. The labour productivity growth in the woodworking industry was positive. The exception was the year 2008. The largest increase of the labour productivity in the woodworking industry was noted in 2010 and 2012. It amounted to respectively 107.7% and 108.2%. In the analyzed period it increased significantly the potential of in-kind corporate of the woodworking industry enterprises.

In 2014 the gross value of fixed assets was by 84.4% higher than in 2005 and it amounted to 1,055.2 billion PLN. Positive trends in this area were also noted in the manufacturing. The production potential development is also confirmed by an increase in the production scale i.e. the volume of the wooden products produced in the analysed period. In the analyzed period the production of the plywood consisting of wooden sheets has doubled. There was also noted the chipboard production increase (by 869 dam3.). In 2014 the chipboard production reached 4809 dam^3. The research results show that in the analyzed period the production potential of Polish woodworking industry has increase which is confirmed by presented economic and production data.

REFERENCES

1. Gejdoš, M.; Potkany, M. (2015): Development of market with wood in Slovakia and Central Europe, Wood Processing and Furniture Manufacturing Challenges on the World Market, Proceedings of Scientific Papers Wood-Based Energy Goes Global, Dubrovnik, Croatia
2. Grzegorzewska E. (2013): The influence of global economic crisis on import and export of furniture in Poland, Annals of Warsaw University of Life Sciences - SGGW. Forestry and Wood Technology, No. 82
3. Grzegorzewska E. (2014): Timber Market Set Against the Activities of Wood Sector Enterprises in Poland, Position and Role of the Forest Based Sectorin the Green Economy, Proceedings of Scientific Papers, Zagreb, Croatia
4. Grzegorzewska E.; Stasiak-Betlejewska R. (2014), The influence of global crisis on financial liquidity and changes in corporate debt of the furniture sector in Poland, Drvna Industrija, Vol. 65, No. 14
5. Nowosielski S. (2012): Production potential of the company. The essence, structure and planning, Przedsiębiorczośc i Zarządzanie, Tom VIII, zeszyt 17
6. Production of major industries in 2006, Central Statistical Office of Poland (GUS), Warsaw
7. Production of major industries in 2007, Central Statistical Office of Poland (GUS), Warsaw
8. Production of major industries in 2008, Central Statistical Office of Poland (GUS), Warsaw
9. Production of major industries in 2009, Central Statistical Office of Poland (GUS), Warsaw
10. Production of major industries in 2010, Central Statistical Office of Poland (GUS), Warsaw
11. Production of major industries in 2011, Central Statistical Office of Poland (GUS), Warsaw
12. Production of major industries in 2012, Central Statistical Office of Poland (GUS), Warsaw
13. Production of major industries in 2013, Central Statistical Office of Poland (GUS), Warsaw
14. Production of major industries in 2014, Central Statistical Office of Poland (GUS), Warsaw
15. Production of major industries in 2015, Central Statistical Office of Poland (GUS), Warsaw
16. Skalik J. 2012, Aktywizacja potencjału rozwojowego przedsiębiorstwa, Determinanty potencjału rozwoju organizacji, A. Stabryła i K. Woźniak, Wyd. Miles.pl, Kraków
17. Statistical Yearbook of Industry 2006, Central Statistical Office of Poland (GUS), Warsaw
18. Statistical Yearbook of Industry 2007, Central Statistical Office of Poland (GUS), Warsaw
19. Statistical Yearbook of Industry 2008, Central Statistical Office of Poland (GUS), Warsaw
20. Statistical Yearbook of Industry 2009, Central Statistical Office of Poland (GUS), Warsaw
21. Statistical Yearbook of Industry 2010, Central Statistical Office of Poland (GUS), Warsaw
22. Statistical Yearbook of Industry 2011, Central Statistical Office of Poland (GUS), Warsaw
23. Statistical Yearbook of Industry 2012, Central Statistical Office of Poland (GUS), Warsaw

24. Statistical Yearbook of Industry 2013, Central Statistical Office of Poland (GUS), Warsaw
25. Statistical Yearbook of Industry 2014, Central Statistical Office of Poland (GUS), Warsaw
26. Statistical Yearbook of Industry 2015, Central Statistical Office of Poland (GUS), Warsaw
27. Structural changes of groups of the national economy entities entered in the REGON register in 2014. Central Statistical Office of Poland (GUS), Warsaw
28. S̆upin, M. (2014): The Impact of the Global Recession on Wood Processing Industry and Wood Products Trade and The Road To Recovery, Position and Role of the Forest Based Sectorin the Green Economy, Proceedings Of Scientific Papers, Zagreb, Croatia.
29. Ulewicz, R.; Jelonek, D.; Mazur, M. (2016): Implementation of logic flow in planning and production control, Management and Production Engineering Review 7 (1), pp. 89-94.

Authors address:
Grzegorzewska, Emilia*[1]; Stasiak-Betlejewska, Renata[2]
[1] Department of Technology and Entrepreneurship in Wood Industry, Faculty of Wood Technology, Warsaw University of Life Sciences (SGGW), Poland
[2] Institute of Production Engineering, Faculty of Management, Częstochowa University of Technology, Poland
*Corresponding author: emilia_grzegorzewska@sgggw.pl

QUALITY MANAGEMENT SYSTEM OPERATION IN THE WOODWORKING INDUSTRY

Ulewicz, R.

ABSTRACT

Quality management system is aimed at enterprise development by the management system improvement and product quality increase. The quality improvement is understood as improvement of the final product quality with all related processes. It is connected with realization of the quality principles implementing based on the good relations with clients, employees and suppliers towards the standards meeting that included in the quality management system requirements. Author presents research findings on the quality improvement in the chosen Polish woodworking industry enterprise.
Key words: quality, wood, improvement, production.

1. INTRODUCTION

Quality management is an essential component of any organization, but it is not a sufficient element which guarantees the achievement of competitive advantage on the market. An open issue is to ensure and management of the quality in the ever-changing turbulent business environment. One of the most important elements of the competitiveness of enterprises is the appropriate level of product quality. In the the furniture industry we achieve it through: long experience in production, unique design, use of the latest technologies, use of appropriate materials, work of modern machinery and equipment. Qualitative product is desired by customer, going further qualitative product tailored to individual customer preferences in the price of furniture produced systemically is the largest customer expectation and for managers greatest organizational and logistical challenge. Without the improvement of realized processes the achievement of such a state is impossible. The basis for improvement of the production process is optimal connection and utilization of the factors of production resulting from the need to meet customer demands, cost pressure and increasing the role of internal and external flexibility [1÷4]. The aim of the undertaken actions by the furniture companies is to achieve measurable economic and production effects such as: improving the efficiency of the production process, the timeliness of performed orders, reducing the material in the course of production, stock, shortening of interoperational time and identification of factors affecting the quality perceived by customer. One of the most popular solutions due to their effectiveness in terms of improving the organization of production are Lean solutions known from the automotive industry. The basic philosophy of Lean is to fight waste and maximizing the use of existing potential of the organization.

The key to success is high level of quality while providing production flexibility at low coefficient of material during production. Today's cooperation with customers is based on trust, which stands for high quality achieved through the implementation and execution of the overall system of quality policy [5÷8].

The purpose of this system is:

- implementation of innovative techniques and technologies of production,
- use of expected by the market raw materials supplied by reputable suppliers,
- quick reaction to changing customer needs,
- hiring of qualified and experienced personnel and continuous improvement of their qualifications,
- ensuring the competitiveness of products by increasing production efficiency.

The above goals are realized through:

- continuous improvement of the organization in technical and organizational dimension,

- commitment of all available resources in qualitative activities,
- monitoring and meeting the expectations and requirements of customers of the enterprise,
- increasing the awareness of employees on the importance of quality and responsibility of everyone for the quality of performed work.

The question arises whether the system of ensuring and quality management keep pace with organizational changes and whether it is flexible enough to provide sufficient qualitative ability.

2. RESEARCH OBJECT

The research was carried out in the company of a group of small and medium-sized enterprises employing up to 250 employees. In the manufactured product range are furniture from 12 collections as well as independent types of products e.g.: chests of drawers, glass-case, benches, tables, bookcases, beds, chairs and others. The organizational structure is hierarchical, based on process management. The company has an internal quality assurance system in accordance with ISO 9001:2008 standard. The evaluation of the facts of the company, we can conclude that we are dealing with an excessive diversity of products. After conducted research consisting in the direct interview with the employees of the individual departments, it was found that the reasons for such a large diversity of products is:

- Implementation of new products without proper marketing analysis, lack of sales simulation.
- Lack of support of simulation tools and support of optimization of orders.
- There is no concept of modularity and interchangeability of components between different series of furniture or various types of furniture.
- Constructing new sets and types of furniture from the beginning without the use of standard elements base.
- Error of concept involving the assumption that the greater assortment the higher sales. The analysis conducted for the year 2014 and 2015 showed that 25% of assortment realizes 72% of turnover.

Currently, the database contains 1125 of indexes of offered assortment of solid wood and precious veneers.

3. METHODOLOGY OF RESEARCH

The aim of carried out research is to determine whether organizational changes have an impact on the level of quality of manufactured products, the type of occurring incompatibilities and whether implemented changes affect the level of safety of workers. Based on data from the department of internal quality control and from complaint department there was established the level of quality and was carried out quantification of incompatibility before the introduction of changes in the range of improvement and optimization of material flow during production. After the implementation of changes based on the concept of Glenday sieve there was carried out re-examination of the level of quality and determined the structure of defined incompatibilities. There were also used questionnaire surveys of auditorium type, aimed at obtaining information on the problems in the implementation of new concepts and problems in adapting to new standards and the impact of changes on the level of quality of realized processes, products and the level of safety of workers.

Application of the principles of Glenday sieve was aimed at determination of timetable for implementing production of any product at each cycle of flow, prepared to meet the needs of the market, even in changing conditions. One of the elements to eliminate waste in furniture factory was the identification of the competencies and skills of employees in terms of suitability for standard operation (green line), and for special orders of non-standard work (red line). Improper selection of employees may contribute to the excessive burden and stress of employees. The productivity of such a worker

drops significantly therefore many times it is an element determining creation of bottleneck on the line. Overloaded and stressed employees are more likely to make mistakes which in turn contributes to the increase of the percentage share of incompatibility. In this case there should be eliminated the possibility of accumulation of too many types of waste in the systems and manufacture processes. There was distinguished the group of products called green group. This group includes 68 products of 3 collections representing 50% of production. Categorization shown in Table 1 demonstrated that the production of 68 types of furniture can be carried out according to a fixed production volume strategy (a group of "green"). There were also separated two groups of workers, one called the Greens to serial work - standard and a group of blue to work with single or short serial furniture.

Table 1. The results of grouping products

Cumulative Sale [%]	Number of products	Codes of groups
50 %	68	Green
95 %	563	Yellow
99%	787	Blue
1% remaining	338	Red

Sources: [8]

In the next stage of data analysis to determine the products for which the production according to the strategy of constant production would be the most effective, there was determined the average monthly volume of production, standard deviation (from the average value of production) for the period of 12 months and the coefficient of variation. This factor is a result of ratio of standard deviation to the mean value multiplied by 100%. Such range of assortment of manufactured furniture of green category according to the coefficient of variation have revealed that better results of application of strategy of constant volume of production will be achieved for products of two collections. Among this group there were also product types: coffee tables, chests of drawers and cabinets, available in four colors of veneer. There was created a separate production line, on which are implemented only products "green" group. After the implementation of a separate line there was made quantification of incompatibilities.

4. RESEARCH RESULTS

On the way of systematic analysis of furniture production process there were selected the most recurrent incompabilities in the production of furniture in the examined factory. To the most frequently repeated incompabilities and their causes we can include:

- Lack of correctness of overall mechanical working. Machines used in the production cycle are not subject to constant control of precision and accuracy of work. Lack of tools of comprehensive machine maintenance. Defects of uneven planing and sanding, cutting and surface burns are extremely difficult to remove in the next stages of production.
- Inadequate quality of materials used in production.
- Inadequate quality of adhesives used in the manufacture. Failure to meet deadlines of suitability, resistance to aging and storage conditions. Most of the currently used adhesives are products based on aqueous dispersions and they are not resistant to frost and overheating.
- Inadequate quality of abrasive materials used in production. Constant size of the abrasive grains is very important, and allows to avoid the formation of so called "wild scraches" typically noticeable only during the dyeing and surface varnishing.
- Inadequate quality of wood-derivative materials of MDF type, particle board and blockboard, plywoods and etc..

- Inadequate quality of paints and varnishes dyes. In particular this concerns stability of colors - UV resistance and resistance to mechanical factors normally occurring during the use of the furniture.
- Failure to meet the necessary periods and production cycles. It is extremely important during the process of surface finishing with painting and varnishing materials. Lack of application of the recommended periods of storage, the rigors and interoperable regimes might reflect on the quality of the product.
- Improper selection of the wood drawing and veneers. Improper selection of orientation of graining of wood - horizontal or vertical. Type of natural grain of wood - Flader or Pasiak. Errors in the process of connecting adjacent to each other veneer leaves - symmetrical, mixed etc..
- Correctness of dyeing wood in case of furniture made of solid wood. This applies particularly to reproducibility of color on the individual elements of furniture, masking unwanted discoloration, transparency of the dye and visibility of natural grain of wood and dyeing of porosity of type of container and wood pores.
- Correctness of paint and varnish coverage - homogenous amount of varinsh substance, color and gloss reproducibility on individual elements. Inadequate number of application layers. Durability and aesthetics of connections between the individual elements of furniture.
- Failure to meet the requirements of air circulation.

From the results of the research was created Pareto-Lorenz diagram, which shows that the greatest impact on the level quality of manufactured furniture have three reasons, which represent 73% of all the observed incompatibilities. To these incompatibilities are included: mechanical processing defects, mechanical damages and so-called wild scratches. Elimination of these three elements should reduce more than half the number of incompatible products.

Table 2. Quantification of incompatibilities before the organizational changes

No	Incompatibilities	Share [%]	Accumulated share [%]
N1	Disadvantages of mechanical processing	32	32
N2	Mechanical defects	29	61
N3	Wild scratches	12	73
N4	Misplaced circulation holes	6	79
N5	Defects of veneer	5	84
N6	Hyperpigmentation	4	88
N7	Inequalities on the varnish	4	92
N8	Inadequate dyeing of wood	3	95
N9	Bad juxtaposition of the drawing	3	98
N10	Defects of masking connections	2	100

A result of research there also was found that in most cases, after the manufacture of the first batch of new product quality control reveals a number of incompatibility (elements which do not meet the requirements). This state was influenced by the fact that the production plan was not sufficiently and in detail elaborated. A large number of detected incompatibiities was not the result of machine failures, but in most cases (about 80%) was caused by inexperience or improper preparation of the workers and in terms of wood processing as well as between operating transport rules (lack of competencies results in lack of commitment in the field of care for manufactured and machined components). As a result, this phenomenon has led to occurrence of considerable amount of mechanical damages.

After extracting the red and green production line and two employees teams for standard working (greens) and nonstandard (blues) there was made analysis of quality for the assumed time iterval. The results of the quantification of incompatibility for the assumed period under study are shown in Table 3, and graphical comparison of the results in Figure 1.

Table 3. Quantification of incompatibilities after the organizational changes

No	Incompatibilities	Share [%]	Accumulated share [%]
N1	Disadvantages of mechanical processing	17	17
N3	Wild scratches	15	32
N6	Hyperpigmentation	14	46
N2	Mechanical defects	11	57
N8	Inadequate dyeing of wood	11	68
N5	Defects of veneer	10	78
N9	Bad juxtaposition of the drawing	7	85
N7	Inequalities on the varnish	6	91
N4	Misplaced circulation holes	5	96
N10	Defects of masking connections	4	100

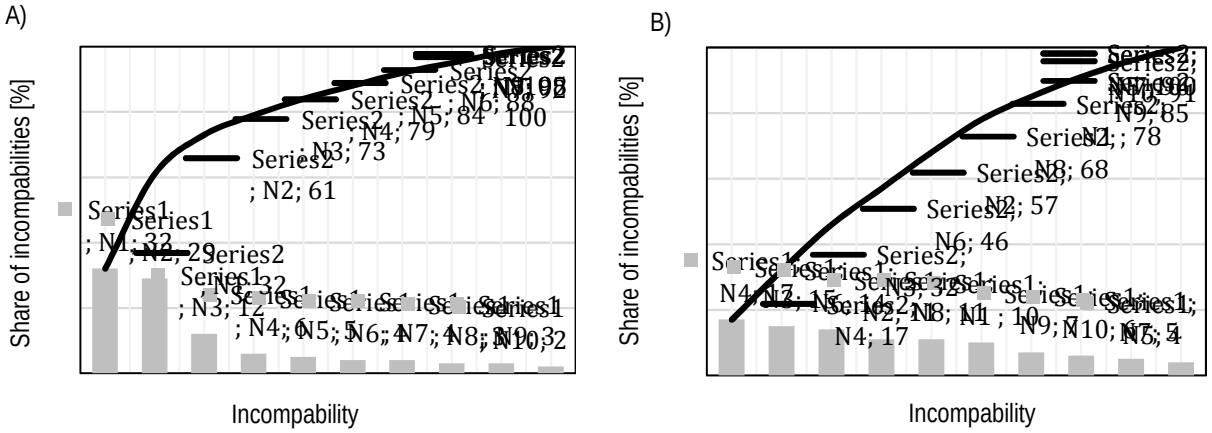


Figure 1. A comparison of the percentage share of incompatibilities: A) before the adaptations, B) after isolation of green line

5. DISCUSSION AND CONCLUSIONS

The organization of the production process should be based on regularities, interdependencies that occur in the actual production processes and experiences, allowing you to specify methods, ways of efficient and economicaly justifiable course of production processes. In series production this is not so large problem as in case of high variety of assortment. An important aspect of the selection of organization process is the decision about the spatial distribution and logical grouping of resources. In the analized case of the factory producing furniture we deal with production lines on which often comes to produced assortment change without analyzing the similarities of itinerary of individual products. The result of this approach is a quality problem associated with the human factor. Frequent changes in the assortment, insufficient information, problems with the exchange of information and high staff turnover at different positions have a negative impact on the overall efficiency of the analyzed production system. After conducting the interview and research of so called day photograph it was found that there is the possibility to take advantage of technique of line balancing (balancing), which consists in allocation of a specific set of operations for jobs and it means even distribution of work at various posts. But it is not possible for the entire product range. In order to isolate a group of products that generate the highest turnover, and which are characterized by similar technological operations there was used method of Glenday sieve. This method allowed the identification of so called areas of excessive complexity, which

do not provide added value. With the help of sieve there were identified the areas in which you must improve production capacity.

The results of research of quality level indicate the positive effect of the application of Glenday sieve. In the period of three months after the separation of the green line and the assignment of group of employees for working specifically on this line (green group) and a group of employees (blue group) to non-standard work there was achieved reduction in detected incompatibilities by 40%, significantly changed also the structure of incompatibilities. There was observed a significant reduction in incompatibilities related to the human factor: mechanical defects, errors during mechanical processing, damage during transport. Some types of incompatibilities occur only on the products line, conventionally characterized by high volatility of assortment. For this type of incompatibilities we can include, eg. misplaced circulation holes. This type of incompatibilities, as well as drawbacks of masking connections did not occur even once on the green line. On the green line also several advantages was achieved, firstly lead time was reduced, consequently the amount of material during production. In the opinion of staff (survey research) this significantly influenced an improvement of the level of safety and comfort of work. To manufacture of products of high volatility was qualified staff with wide experience and competence (group of blue), as opposed to the production on the green line here is not rigidly set time regimes. Special incentive bonus is granted for this group of employees. For a period of four months from the introduction of organizational changes we observe a reduction in the process share of incompatibilities associated with the human factor and the growing trend of effectiveness factors of the production system.

Acknowledgements: Many thanks to Mr Krzysztof Krysiak and Krysiak Furniture company for their cooperation and the possibility of implementation elements of Glenday's sieve method in manufacturing processes.

REFERENCES (alphabetical order)

1. Barta, B.; Kovats, J. (2015) Short note added value among the furniture manufacturing SMES, Wood Research 60(6), pp. 1017-1024.
2. Borkowski, S.; Stasiak-Betlejewska, R.(2010): Analysis of bent furniture production costs, In: 3rd WoodEMA International Scientific Conference on Wood Processing and Furniture Manufacturing - Present Conditions, Opportunities and New Challenges Location: Vyhne, Slovakia OCT 06-08, 2010 pp. 109-115.
3. Guimaraes, M.; Buarque, L.; Jose, M. A.; Ribeiro, D.; Luis, J.; et al. (2015): Participatory ergonomics intervention for improving human and production outcomes of a Brazilian furniture company, International Journal of Industrial Ergonomics 49, pp. 97-107.
4. Nowakowska-Grunt, J. (2014): Modeling of innovation processes in the management of SME's enterprises activities. Advanced Materials Research 1020, pp. 789-795.
5. Paliszkiewicz, J. (2007) Knowledge management: an integrative view and empirical examination, Cybernetics and Systems An International Journal 38 (8), pp.825-836.
6. Pustejovska, P.; Brozova, S.; Ingaldi, M. (2014) The Crucial Logistics Units In Metallurgical Production, In: CLC 2013: Carpathian Logistics Congress - Congress Proceedings, pp. 572-576.
7. Skowron-Grabowska, B. (2005): Simulation of supplies and distribution logistics systems. In: WMSCI 2005: 9th World Multi-Conference on Systemics, Cybernetics and Informatics 3 pp. 47-50
8. Ulewicz, R.; Jelonek, D.; Mazur, M. (2016): Implementation of logic flow in planning and production control, Management and Production Engineering Review 7 (1), pp. 89-94.

Authors address:
Robert Ulewicz*[1]
[1] Institute of Production Engineering, Faculty of Management, Czestochowa University of Technology, Czestochowa, Poland
*Corresponding author: ulewicz@zim.pcz.pl

THE NEED OF INTRODUCTION OF ECO-INNOVATION ASPECTS IN PACKAGING FROM THE CUSTOMERS' PERSPECTIVE

Loučanová, E.; Kalamárová, M.; Olšiaková, M.

ABSTRACT

The paper deals with the need to use eco-innovation aspects in packaging from the customers' perspective with a potential of wood based products usage. Its evaluation involves various areas that include eco-innovative aspects and are focused on all dimensions of sustainable development. The resulted facts show the need for eco-innovation from the perspective of Slovak customers (48 %) and a material perception that meets the eco-innovative aspects of packaging material innovation.
Key words: innovation, eco-innovation, packaging, packaging innovation, sustainable development.

1. INTRODUCTION

The economic growth covering the needs of the society in relation to sustainable development is discussed in the National Strategy for Sustainable Development for the Slovak Republic. Within its principles it also focuses on ecological principle, which takes into account the criteria of biodiversity maintaining and supporting, vitality and ecosystems resistance, spatial arrangement optimization and functional use of the landscape and ensuring its spatial system of ecological stability, ensuring and support of life supporting systems, maintenance of high quality of environmental components, minimization of non-renewable resources use and preferential use of renewable resources within their reproduction capacities (Loučanová a kol., 2015).

Lešková (2009) states that eco-innovations reduce material requirements, use closed material flows or create, respectively use new materials. They also focus on energy requirement reduction or create or use alternative energy sources, they reduce overall emissions into the environment or existing environmental burdens and health risks for the general support for the idea of healthy lifestyles and sustainable consumption. Eco-innovation support mainly ecological principle of the National Strategy for Sustainable Development in collaboration with its effective principle, encouraging the eco-innovation performance of enterprises introducing these innovations as well as their sustainable development, which is one of the priorities of the European Union and it is also supported by the UN, OECD and others.

Eco-innovations are innovative products, processes or organizational innovations that reduce environmental costs, increase the acceptance by the society and contribute to sustainable development. Eco-innovations concern the product as well as its all components at its hierarchy levels, where the packaging is the part of the actual product.

Each company should monitor changes in consumer preferences when choosing the packaging and its launching on the market. It also must draw its attention to new technologies of packaging production. Through the packaging, it is also possible to reveal the relationship of the company to the environment and nature by finding whether the company uses scarce or recycled materials (Pajtinková-Bartáková, Gubíniová, 2012).

The packaging can be understood as the tool or the set of tools protecting the product from potential damage. It allows better handling, facilitates the sales and consumption of products (Zeman, 2005).

The packaging has a great potential to contribute to sustainable development through its functions. It is needful to ensure information how packaging functions and properties influence sustainable development among consumers, suppliers, authorities, as well as the media. To fulfill the needs of the society in relation to sustainable development the packaging should meet the environmental, social and

economic dimensions (Lindh et al, 2016; Dzian, 2014; Paluš et al, 2015; Paluš,Šupín, 2004; Šupín, 2011). Within eco-innovation, the packaging is oriented mainly to the environmental dimension. Its need from the perspective of customer perception with the potential of wood based materials usage; we will explore in this paper.

2. METHODOLOGY

The basic approach to the issue of launching the eco-innovation packaging aspects from the perspective of customers in Slovakia is to analyze the state of the searched phenomenon by questioning. Then through the descriptive methods, there are analyzed mutual relations of areas and their dimensions in the context of sustainable development.

The questioning was realized as a random survey via internet. The survey sample size included 100 respondents. The questionnaire consists of two parts, where the first one is focused on demographic data about customers and the second one was aimed at the core issue of the searched phenomenon – the need to use eco-innovation aspects in packaging from the perspective of customers. The survey results were processed into a database, analyzed and then by the synthesis the results evaluated.

The obtained data describe the state in the researched area in Slovakia and detect causalities and coherences.

3. THE NEED TO USE ECO-INNOVATION ASPECTS IN PACKAGING FROM THE CUSTOMERS' PERSPECTIVE

The survey focused on the need to use eco-innovation aspects in packaging from the customers' perspective and a material perception that meets the eco-innovative aspects of packaging material innovation. The used method of the primary research was a questionnaire, where 100 random respondents (63 % women and 37 % men) were surveyed.

94 % of respondents said that packaging affects their buying decision, from which we can conclude a significant impact of packaging on product sale. At the point of sale, the most influential factor as a part of the package is design (44 %), followed very closely by eco-material - recyclable (19 %), brand (19 %) and information on the packaging (18 %). Within the innovation of packaging, 66 % of respondents prefer the innovations focused on the larger packaging of the products and design innovation.

According to the report of Pro Carton (2010) over 64 % of respondents said that packaging should consist of environmentally friendly materials and over 55 % felt that packaging should contain as little plastic as possible. When monitoring environmental friendliness of the packaging material, according to our survey the eco-material used for packaging affects almost half of respondents (48 %) who prefer a recyclable material from a non-recyclable material.

Within the perception of materials which meets the eco-innovation aspect, customers for such materials consider wood (90 %), paper (86 %), materials made of grass and straw (86 %), bamboo (52 %), wood-based materials (47 %), glass (65 %), see Figure 1 (respondents have the opportunity to choose more answers and to mention other materials which meet eco-innovative aspect of packaging innovation, but they did not use this option). For comparison according to Opinion Research (Glass Packaging Institute, 2010) consumers' rate paper and glass packaging as the best for the environment.

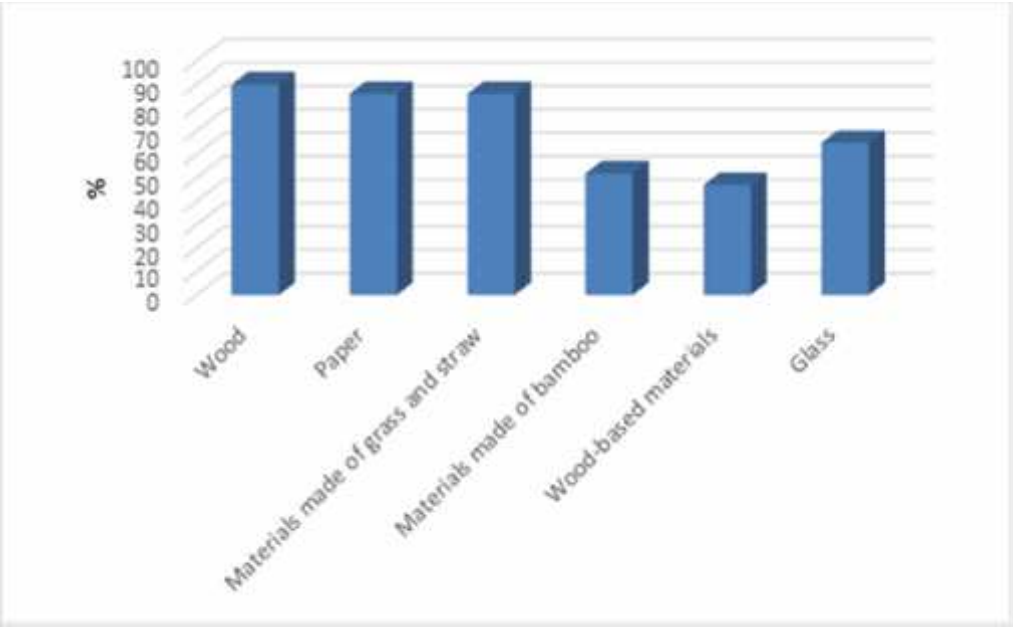


Figure 1. Customers 'perception of materials fulfilling eco-innovation aspect

The results indicate that the packaging innovation by consumer perception should be oriented mainly towards their design, which, in the context of sustainable development should be focused on the social dimension. They should be focused on the social perception of customers, such as packaging with applications and games that encourage connecting people in communities and so on. Similarly, another dimension – economic perception is supported by customers who would within a packaging innovation, welcome products in large packages, which tend to be more economically and at the same time by enlargement the packages are reduced in number, thereby reducing the environmental stress. In addition, within the environmental dimension, customers are increasingly aware of the need for packaging recycling. Therefore it is possible to say that the Slovak customer perceives packaging innovations which influence them during the purchase. Packaging innovations, that support sustainable development dimension, affect the purchasing behavior significantly. The finding also confirmed other research, there is a significant relationship between Buying Behavior and Packing Innovation (Ahmed, Parmar, Amin, 2014) and innovation in the packaging design increase the value of the product (Poturak, 2014).

4. CONCLUSION

Nowadays, innovation is focused on the needs of society in relation to the sustainable development. As part of its principles, it focuses on ecological, economic and social dimension. Simultaneously it focuses on reducing energy demand or creating respectively using alternative energy sources, reducing its overall emissions to the environment or existing environmental burdens and health risks for the general support of healthy lifestyles and sustainable consumption. Slovak customers recognize the need for innovation and at the same time these innovations focused on all dimensions of sustainable development significantly influence buying behavior. Respondents are influenced by eco-innovations in a lesser rate but are well aware of the need for eco-innovation and significantly recognize materials complying with eco-innovative aspects of innovation in terms of packaging material.

Acknowledgements: The authors would like to thank the European Cooperation in the field of Scientific and Technical Research – COST. This paper was elaborated within the frame of COST Action FP1405 "Active and Intelligent Fibre-Based Packaging – Innovation and Market Introduction (ACTINPAK)" and of Grant project 1/0473/16 "Dynamics and Determinants of Wood Based Products Market in the Slovak Republic" and Grant project 1/0756/16 "Identification of consumers' segments according to their affinity for environmental marketing strategies of business entities in Slovakia". The authors therefore would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences too.

REFERENCES (alphabetical order)

1. Ahmed, R.R.; Parmar, V.; Amin, M.A. (2014): Impact of Product Packaging on Consumer's Buying Behavior. European Journal of Scientific Research 120 (2). pp. 145-157.
2. Dzian M. (2014): Prostredie šírenia wom na Slovensku v rámci generácie Y. In: Globalizácia a je sociálno-ekonomické aspekty ´14. Slovensko. 2014. 89-95.
3. Lešková, A. (2009): Politika eko-inovácií a jej prejavy v automobilovom priemysle. Transfer inovácií´13. pp. 37-40.
4. Lindh, H.; Williams, H.; Olsson, A; Wikström, F. (2016): Elucidating the Indirect Contributions of Packaging to Sustainable Development: A Terminology of Packaging Functions and Features. Packaging Technology and Science 29. pp. 225-246.
5. Loučanová, E.; Parobek, J; Kalamárová, M; Paluš, H.; Lenoch, J. (2015). Eco-innovation performance of Slovakia. Procedia - economics and finance, 26, pp. 920-924.
6. Pajtinková Bartáková, G.; Gubíniová, K. (2012): Udržateľný marketingový manažment. Slovensko. Bratislava. 1AM press, 2012. 241 s.
7. Paluš, H.; Parobek, J.; Liker, B. (2015): Trade performance and competitiveness of the Slovak wood processing industry within the Visegrad group countries. Drvna industrija 66 (3), pp. 195-203.
8. Paluš, H.; Šupín, M. (2004): Competitiveness of selected clusters in the slovak forest industry. In: The growth and developement in forestry and wood industry : scientific book. - Zagreb, 2004. 17-20.
9. Poturak, M. (2014): Influence of Product Packaging on Purchase Decisions. European Journal of Social and Human Sciences 3 (3): pp. 144 -150.
10. Pro carton. (2010): Consumer Attitudes on Packaging & Sustainability: Summary of a report commissioned from GfK by Pro Carton, 2010.
11. Šupín, M. (2011): Analýza vplyvu globalizácie na slovenský drevársky priemysel v prvej dekáde 21. storočia. In: Marketing a obchod 2011 : vplyv volatility a interdependencie v svetovom hospodárstve na marketing a obchod. Slovensko, 2011. 282-286.
12. Zeman, S. (2005): Balenie a obalová technika. Nitra: Slovenská poľnohospodárska univerzita, 2005. 177 s.
13. ***: Glass Packaging Institute (2010): Opinion Research.
14. URL: www.gpi.org/health.

Authors address:
Loučanová, Erika*[1]; Kalamárová, Martina[2]; Olšiaková, Miriam[3]
[1] Department of Marketing, Trade and World Forestry, Faculty of Wood Sciences and Technology, Technical University in Zvolen, Zvolen, Slovakia
*Corresponding author: loucanova@tuzvo.sk

INTENSIFYING SMES BUSINESS NETWORKS IN FORESTRY

Chobanova R.

ABSTRACT

The paper attempts to summarize the current common challenges to be jointly addressed by SMEs in forestry. In this respect it has suggested developping and intensifying SMEs business newtorks applying some standards for business exellence among which are the Supply Chain Operational Refenece (SCOR), as well as the newly launched Design-Chain Operational Refenece (DCOR). Incorporating the both – challenges and solutions is in the core of the new ideas for intensifying SMEs business networks in forestry, named VOFIS (virtual office for forest industry support (VOSIF) and virtual educational platform (VEP). These innovative ideas are aimed to contribute to the cross-border cooperation between Bulgaria and FYROM, and are developed in the frame of a joint project of the Bulgarian academy of sciences (BAS) and Macedonian academy of sciences and atrs (MASA).
Key words: forestry, SMEs, networks, business, EU

1. INTRODUCTION

The grassroots for defining the topic of intensifying SMEs business networks in forestry are in the major cross-border problems identified by IPA Cross-border cooperation programme 2014 - 2020: loss of competitiveness, which is a consequence of the ongoing restructuring process, loss of traditional markets and lack of managerial skills in forestry sector. In this respect developing new ideas for intensifying SMEs business networks in forestry as VOFIS (virtual office for forest industry support (VOSIF) and virtual educational platform (VEP) in cross-border cooperation between Bulgaria and FYROM, developed by the Bulgarian academy of sciences (BAS) and Macedonian academy of sciences and arts (MASA) are connected with defining common challenges and then conditions and best practice solutions to be meet.

2. THE CHALLENGES

The forest-based industries are currently facing several challenges. The 2013 Communication “A New EU Forest Strategy” and the accompanying “Blueprint for the EU Forest-Based Industries” (F-BI) define following challenges global competition, the availability of energy and wood supplies, the role of the sector in limiting climate change.

The both documents confirm the persistence of these challenges and their impact on the overall competitiveness of EU F-BI in a global context. The provided arguments are that all segments of the value chain, including the furniture sector are affected by the access to sustainably-sourced raw materials, the cost and complications of harvesting wood in the EU, price increases driven by competing demand (e.g., from the bio-energy sector), comparatively higher energy costs in the EU and a more complex and demanding policy environment. Because of some of these challenges have also an impact on consumption patterns, the degree of information available to the final customers becomes of relevance.

The policy problem to be solved is related to a specific type of market failure, i.e. incomplete information, which triggers a problem of adverse selection due to the following features of the furniture industry: Most of the quality features of furniture products belong to the categories of experience and credence attributes: this means that consumers might not always be entirely equipped to fully incorporate quality features in purchasing decisions, as well as to distinguish between high- and low-quality products. This can generate problems of adverse selection, in which consumers do not fully adjust their willingness to pay to the difference in quality of products available on

the market. The adverse selection problem is further exacerbated by the fact that retailers that sell both high- and low-quality furniture might not have the same incentives as manufacturers in making quality differences crystal clear for customers. The problem is also aggravated by emerging trends such as increased competition from non-EU countries, growing price-sensitivity of furniture demand generated by reduced disposable income, and the rise of online furniture stores, which make the quality features of furniture even more difficult to test in practice before purchase. It must also be recalled that online interaction between consumers might, in principle, fill some of the information gaps on experience qualities (e.g. through rating of specific pieces of furniture by other consumers), but not on credence qualities, and not for all furniture products existing on the market.

Other problems have been highlighted in EU Forest Strategy and to be addressed are as follow: Existing product guarantees only partially address the issue as, in the case of furniture, quality problems can become visible after a guarantee has expired and when complaints cannot be enforced. Several factors including the globalization of value chains, new sourcing strategies, and in particular the growing diffusion of new retail formats have altered vertical relations between manufacturers and retailers and made competition on "quality signalling" fiercer. In addition, due to the structure of furniture production in the EU, manufacturers are more likely to be the side with less bargaining power in the vertical relationship, which also affects the type of product information that is ultimately communicated at the point of sale. As a result, consumers receive confusing messages, as different actors at different levels of the value chain may be interested in providing different types of product information to the consumer.

Another problem is the provision of information on materials used. As regards information on wood and woodworking products, the EU Timber Regulation[1] entered into force in March 2013, represents a momentous breakthrough because it forbids the placing on the Internal Market of illegally harvested timber or timber products[2] derived from illegal timber and requires operators who place timber and timber products on the market to exercise due diligence.[3] Moreover, to enhance traceability, traders are obliged to keep records of their suppliers and customers. Although this Regulation does not directly affect the amount of information provided to consumers, its enforcement has some clear informational effects: i) it ensures that all wooden furniture products put on the EU market employ wood that was legally logged, thus creating a level playing field in the Internal Market; ii) it foster the collection and transmissions of information at different levels of the value chain, thus enhancing B2B information flows; iii) it allows traceability of wood and woodworking products, thus facilitating the identification of the country of origin of these materials. Conversely, it is worth stressing that the EU Timber Regulation does not address sustainability unless rules applied in the country of harvest take account of this specific issue[4].

Another challenge is the company size structure impact. Firms designing, manufacturing and shipping products in large quantities (particularly, but not only, in the low and middle-price ranges) are leading players and took advantage of their large scale and the availability of huge capital resources to invest in organizing their production and logistics in order to penetrate foreign markets. On the other hand, larger firms find it convenient and profitable to outsource and fragment their activities into many functions carried out by different actors in different locations, and small and medium-sized enterprises are increasingly relying on them for their access to markets.

[1] Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market.

[2] Wooden furniture as well as furniture component materials, with the exception of recycled products, are covered by the EU Timber Regulation.

[3] To exercise due diligence, an operator has to collect information about timber and timber products as well as about his suppliers and other context details (complexity of the value chain, rules in force in the country of harvest, level of enforcement in such a country, etc.), thus being able to conduct a full risk assessment and, when needed, to take risk mitigation measures

[4] The definition of legality applied by the EU Timber Regulation strictly depends on the scope of the laws in force in the country of harvest. Factors that are central in sustainable forest management such as biological diversity or forest productivity are not always embedded in national laws regulating logging. As a result, timber complying with the EU Timber Regulation is not necessarily sustainable. Similarly, sustainable timber is not automatically compliant with the Timber Regulation insofar as the definition of sustainability might not include compliance with laws in force in the country of harvest (note that products made of FSC or PEFC certified timber do not automatically comply with provisions included in the EU Timber Regulation).

The EU furniture sector is predominantly made of SMEs, with around 85% being micro enterprises (fewer than 10 employees) and another 12% of companies being small (10 to 49). Medium-sized companies account for 2%. The semi-finished wooden products represent the upstream segment of the value chain. In 2010, this forest-based manufacturing industry in EU included 184,000 enterprises and employed 1.05 million people, i.e. 0.8% of total non-financial employment. The importance of SMEs is relatively high in niche market segments, primarily for high- end, custom made and design-led products. Overcoming difficulties related to small company size was one of the factors underlying the development of cluster experiences in the furniture sector.

3. CONDITIONS TO MEET CHALLENGES

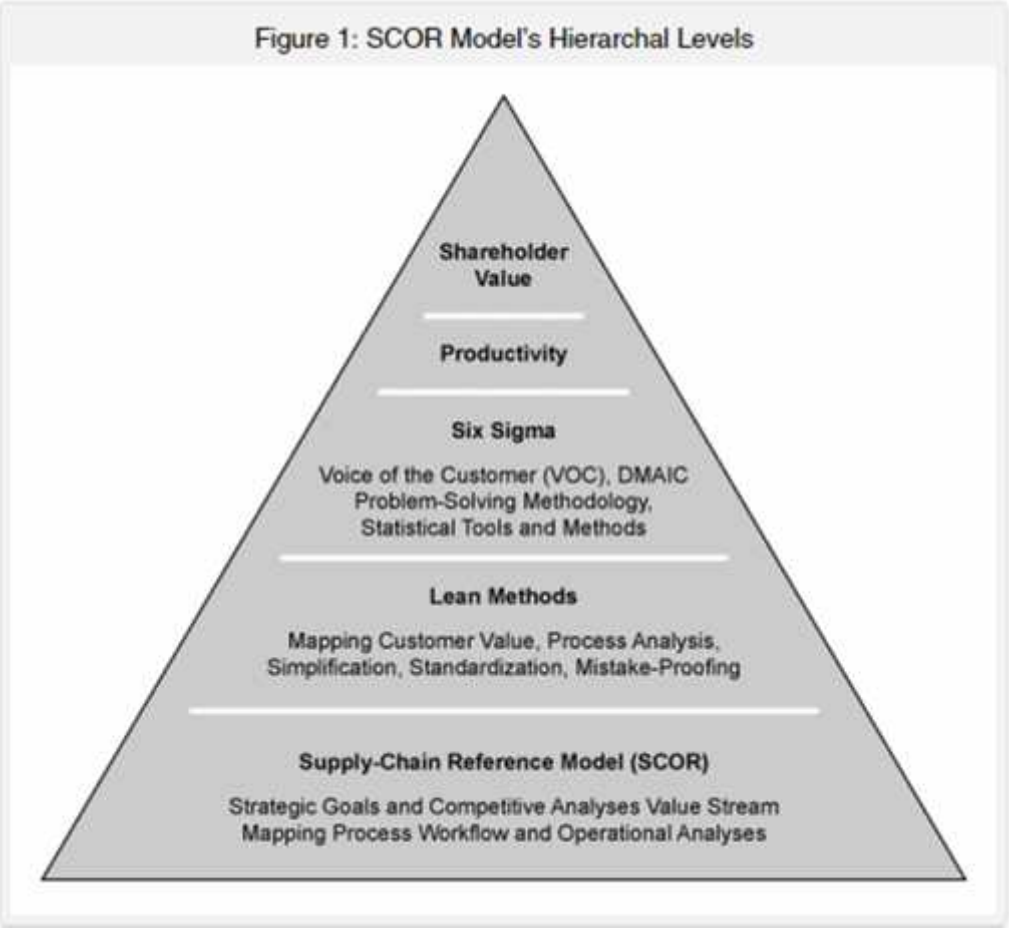
The Report of the World Wildlife Fund (WWF) „Living forests"[5] discussing how to meet future demand for wood products within the finite resources of one planet has defined he following conditions for transformation "…the manufacturing sector in the timber sector of the economy, positively affecting the planet health:
- improving forest management (e.g., providing legal and sustainable forest management, forest planning effective zoning based on a landscape approach, improving the sustainability of forest plantations, the introduction of responsible purchasing policies);
- improvement of technologies (e.g., more efficient use of raw materials and recycling efficiency, the development and introduction of new wood-based materials with a smaller ecological footprint);
- improvement in management (e.g., strengthening social safety nets, more effective implementation of policies and practices);
- improvement of policies (for example, the creation of incentives for reducing the rate of forest lands in the land for other purposes, and unsustainable forest management by implementing public policies that support responsible forest management, which provides a more efficient carbon sequestration, biodiversity and water resources);
- improvement of scientific information database (for example, the implementation of long-term environmental impact studies of different approaches forestry in natural forests and creation managed plantations);
- sustainable consumption (e.g., the development of reusable timber, the new psychology and consumption strategy that would fit the needs of the poor and excluded to irrational and excessive consumption of the rich, which fully applies to wood products, and to food and energy as well as to all the resources and products where land and water are needed) ...".

4. POSSIBLE SOLUTIONS

Developing and managing a supply chain in forestry is a solution recommended by many organizations. The Supply-Chain Council, a global trade consortium in operation with over 700 member companies, governmental, academic, and consulting groups participating in the last 10 years, manages the Supply-Chain Operations Reference (SCOR), the de facto universal reference model for Supply Chain including Planning, Procurement, Manufacturing, Order Management, Logistics, Returns, and Retail; Product and Service Design including Design Planning, Research, Prototyping, Integration, Launch and Revision, and Sales including CRM, Service Support, Sales, and Contract Management which are congruent to the Porter framework.

[5] WWF Living Forests Report: Chapter 4. Forests
and Wood Products, 2012. 41 p.
http://d2ouvy59p0dg6k.cloudfront.net/downloads/living_forests_report_ch4_forest_products.pdf

Figure 1: SCOR Model's Hierarchal Levels



Source:
https://www.google.bg/search?q=supply+chain+operations+reference+model&biw=1920&bih=1075&tbm=isch&imgil=J-JJdLZ4oph7dM%253A%253B0uydWWF-rHqDsM%253Bhttp%25253A%25252F%25252Fwww.slideshare.net%25252Fmelodis%25252Fscor100-for-supply-chain-optimization-8362098&source=iu&pf=m&fir=J-JJdLZ4oph7dM%253A%252C0uydWWF-rHqDsM%252C_&usg=__grNtwiPHuxGCZbRuQ0A_gYoUDp0%3D&dpr=1&ved=0ahUKEwjN7KCK5LTOAhWGCpoKHatjD4sQyjcIRg&ei=kgiqV83bCYaV6ASrx73YCA#imgrc=t37UDvhefOvmxM%3A

The SCOR framework has been adopted by hundreds of companies as well as national entities as a standard for business excellence, and the U.S. Department of Defense has adopted the newly launched.

Design-Chain-Operations Reference (DCOR) framework for product design as a standard to use for managing their development processes. As the Booz Allen Hamilton special report, "Money Isn't Everything"[6] on the R&D spend by companies argues, the more R&D spend means better business results for companies. DCOR is about the innovation processes – ideation, project selection, development, and commercialization. It is a process reference model that has been developed as the cross-industry standard diagnostic tool for all stages of research and development. DCOR enables users to address, improve, and communicate product engineering practices within and between all interested parties. By describing design-chains using standard process building blocks, the model can be used to

[6] Everything Barry Jaruzelski, Kevin Dehoff, and Rakesh Bordia.92005)Money Isn't Everything Barry Jaruzelski, Kevin Dehoff, and Rakesh Bordia. strategy+business, Winter 2005. Booz Allen Hamilton, reprint No. 05406

describe design-chains that are very simple or very complex, using a common set of definitions. As a result, disparate industries can be linked to describe the depth and breadth of virtually any design-chain.[7]

Summary of Supply Chain Operations Reference-model (SCOR)

Metric type	*Outcomes*	*Diagnostics*
Customer Satisfaction / Quality	1. Perfect order fulfillment 2. Customer satisfaction 3. Product quality	9. Delivery to commit date 10. Warranty costs, returns and allowances 11. Customer inquiry response time
Time	4. Order fulfillment lead time	12. Source/Make cycle time 13. Supply chain response time 14. Production plan achievement
Costs	5. Total logistics costs	15. Value added productivity
Assets	6. Cash-to-cash cycle time 7. Inventory days of supply 8. Asset performance	16. Forecast accuracy 17. Inventory obsolescence 18. Capacity utilization

2/22/2002 Richard Zhu/LogisticsManagement 35

Source: https://www.google.bg/search?q=supply+chain+operations+reference+model&biw=1920&bih=1075&tbm=isch&imgil=J-JJdLZ4oph7dM%253A%253B0uydWWF-rHqDsM%253Bhttp%25253A%25252F%25252Fwww.slideshare.net%25252Fmelodis%25252Fscor100-for-supply-chain-optimization-8362098&source=iu&pf=m&fir=J-JJdLZ4oph7dM%253A%252C0uydWWF-rHqDsM%252C_&usg=__qrNtwiPHuxGCZbRuQ0A_gYoUDp0%3D&dpr=1&ved=0ahUKEwjN7KCK5LTOAhWGCpoKHatjD4sQyjcIRg&ei=kgiqV83bCYaV6ASrx73YCA#imgrc=Pdnj2pJyzfiAiM%3A

3. CONCLUSIONS

The forestry based industry is affected by the access to sustainably-sourced raw materials, the cost and complications of harvesting wood, price increases driven by competing demand (e.g., from the bio-energy sector), comparatively higher energy costs and a more complex and demanding policy environment. Because of some of these challenges have also an impact on consumption patterns, the degree of information available to the final customers becomes of relevance. The size structure of enterprises also is a problem to be considered.

The conditions to meet such challenges include improving forest management; improvement of technologies; improvement in management; improvement of policies; improvement of scientific information database; sustainable consumption.

On the firm level such conditions concern application of standards for business exellence among which are the Supply Chain Operational Refenece (SCOR) the newly launched Design-Chain Operational Refenece (DCOR).

Incorporating the understanding for challenges and solutions for intensifying SMEs business networks in tools like a virtual office for forest industry support (VOSIF) and a virtual educational platform (VEP) could contribute to increasing competitiveness of the cross-border cooperation, in our case - between Bulgaria and FYROM.

[7] Caspar Hunsche,2006, Introducing the Design Chain, BPTrends ▪ September 2006 http://www.bptrends.com/publicationfiles/09-06-ART-DoesDesignReallyChain-Hunsche4.pdf

Acknowledgements: I wish to thank the joint projects of the Bulgarian academy of sciences and Macedonian academy of sciences and arts: "Bulgarian-Macedonian scientific and innovative cooperation: Balkan and European perspectives" and "Innovation Cooperaiton Initiatives".

REFERENCES

1. Communication from the Commission: A new EU Forest Strategy: for forests and the forest-based sector, COM(2013)659 final
2. Communication from the Commission: An Integrated Industrial Policy for the Globalisation Era. Putting Competitiveness and Sustainability at Centre Stage, COM(2010)614, 28.10.2010
3. Communication from the Commission: A Stronger European Industry for Growth and Economic Recovery. Industrial Policy Communication Update, COM(2012)582, 10.10.2012
4. Communication from the Commission: Industrial Renaissance COM(2014) 3 NACE Rev. 2 Division 16 ("Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials")
5. Communication from the Commission: innovative and sustainable forest-based industries in the EU, COM (2008)113, February 2008
6. EUROSTAT, Statistics Explained, Manufacture of wood and wood products statistics – NACE Rev. 2, available at: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Manufacture_of_wood_and_wood_products_statistics_-_NACE_Rev._2#Further_Eurostat_information , last accessed in August 2014 .
7. European Commission: A Blueprint for the EU Forest-based Industries (woodworking, furniture, pulp & paper manufacturing and converting, printing), SWD(2013)343;
8. European Commission: the EU furniture market situation and a possible furniture products initiative. Final report, Framework Contract /ENTR/008/006, Brussels, November 2014
9. IPA Cross-border cooperation program Bulgaria – The former Yugoslav Republic of Macedonia 2014 - 2020 http://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/bulgaria/2014tc16i5cb006

Authors address:
Chobanova*; Rossitsa
Economics of the Firm, Economic research institute, Bulgarian academy of sciences, 3 Aksakov st., BG 1040, Sofia, Bulgaria
*Corresponding author: R_Chobanova@iki.bas.bg

THE INFLUENCE OF EXPORT ACTIVITY ON INNOVATIVENESS OF POLISH FURNITURE MARKET

Grzegorzewska E., Więckowska M.

ABSTRACT

Polish furniture industry has special potential in the scope of production and exports. This is confirmed by the unchanged for years good position of Poland in the world ranking of furniture manufacturers and exporters. Competition on the international market and current business conditions necessitate the need for constant growth of innovation activities undertaken by Polish furniture manufacturers. Therefore the purpose of this article is to determine the effect of export activity of Polish furniture enterprises on the level of their innovativeness. Empirical research was conducted among 80 medium and large enterprises operating on the Polish furniture market. The research tool was the interview questionnaire consisting of 31 questions divided into four parts: basic information about a company (I), the development and innovativeness of the company (II), the processing technology of wood-based boards (III), information about a person who gave answers (IV). The study was conducted in the period from September to October 2015. During this period on the furniture market were active 462 companies, where the employment level exceeded 49 people. This means that the study involved 17% of the population. The study analyzed various aspects of the conditions of innovative activity of Polish furniture manufacturers, e.g. determinants of increasing demand for products and services, the objectives of undertaking innovative activity in the area of processes and products. In addition, the attention was paid to the factors restricting innovativeness in the surveyed companies. It should be stressed, that the comparative analysis, in which was taken into account the criterion of conducting or not the export activity, was performed too. For this purpose statistical methods, ie. cross tables and statistical package SPPS Statistics 17.0 were used. These analyses allowed for a detailed evaluation of selected aspects of innovative activity of medium and large furniture enterprises in Poland.
Keywords: export activity, foreign trade, innovation, furniture market

1. INTRODUCTION

Polish furniture industry has a unique potential for production and exports. It is confirmed by good position of Poland (unchanged for years) in the world rankings of the biggest manufacturers and exporters of furniture [Grzegorzewska, Więckowska 2013]. In recent years Poland moved up from 10th to 7th place in the world in terms of production volume of furniture. In this category Poland is overtaken only by China, the United States, Germany, Italy, India and Japan. In the world ranking of the value of exported furniture Poland occupies the 4th place. China dominates (60.08 billion USD), and then - Germany (13.62 billion USD) and Italy (11.68 billion USD) [Grzegorzewska, Stasiak-Betlejewska 2014, Report Polish Furniture Outlook 2015]. That data also confirms the importance of furniture industry for the domestic economy, all the more that Poland ranks only 27 items in terms of value of all goods sent abroad, and on the 24th, taking into account the value of imported goods [Grzegorzewska 2013].

In 2014 the value of furniture industry exports exceeded 8.4 billion EUR, that is approx. 35.2 billion PLN [Statistical Yearbook of Foreign Trade 2015]. Trade exchange of furniture generates the highest positive balance among all sectors of the economy in Poland, approx. 30 billion PLN in 2014. It means that it is the most specialized sector of the Polish economy [Report Polish Furniture Outlook 2015].

The great importance of Polish furniture industry on the international arena requires seeking of new sources of competitive advantage by Polish furniture manufacturers. Undoubtedly growth of the competitiveness in companies belonging to diverse industry sectors, practically always is associated with innovation activities. This is confirmed by numerous studies [Cao, Hansen 2006; Pérez-Luño et al. 2007; Ratajczak, Szostak 2009, Smardzewki 2009; Kusumawardhani, McCarthy 2013, Peter et al. 2013]. In furniture industry special roles play process and product innovations. Therefore, it seems

important to take the issue of the innovative technological solutions implementation, which are characterized by a high degree of cost-effectiveness.

2. OBJECTIVE AND RESEARCH METHODS

The primary objective of the studies was to assess the impact of undertaken export activity on the level of the furniture market innovativeness in Poland. In the first stage, the results of Polish furniture industry were presented in the context of the foreign trade. The primary source of the research material were reports of CSO (GUS) 'Statistical Yearbook of Foreign Trade'. The analysis covered the years 2010-2014. In these analyses, the total value of the furniture that was sent abroad, the level of furniture imports and the trade balance (representing the difference between exports and imports) were taken into account. In the second stage, empirical studies were conducted to determine the impact of export activity of furniture enterprises on their innovativeness level. The research tool was the interview questionnaire consisting of 31 questions, divided into four parts:

- the first part - information about a company,
- the second part - development and innovativeness of the company,
- the third part - technology of finishing wood-based panels,
- the fourth part - information about the person who gave a reply.

The survey was conducting from September to October 2015 in the 80 medium and large furniture enterprises. It is worth noting, that during this period on the Polish furniture market were 462 companies, where the employment level exceeded 49 people. It follows that study involved 17% of the population. Analyzed community was divided into two groups of companies:

- the first group (I) - companies pursuing the export activities (65 companies)
- the second group (II) - companies selling products only on the domestic market (15 companies).

In the study were analyzed various aspects of the conditions of the innovative activity conducted by Polish furniture manufacturers. Among others, some selected factors like: the determinants of increasing demand for products and services, the objectives of undertaking innovative activity in the area of processes and products, the factors limiting innovation implementation in the surveyed companies, were taken into consideration. It should also be stressed, that comparative analyses taking into account the criterion of conducting or not the export activity also were executed. For this purpose were used statistical methods, i.e. cross tables and the statistical package of SPPS Statistics 17.0. The results were presented in the form of the graphs and the table. These analyses allowed for a detailed evaluation of selected aspects of the innovative activity realized by Polish medium and large furniture manufacturers during the last five years.

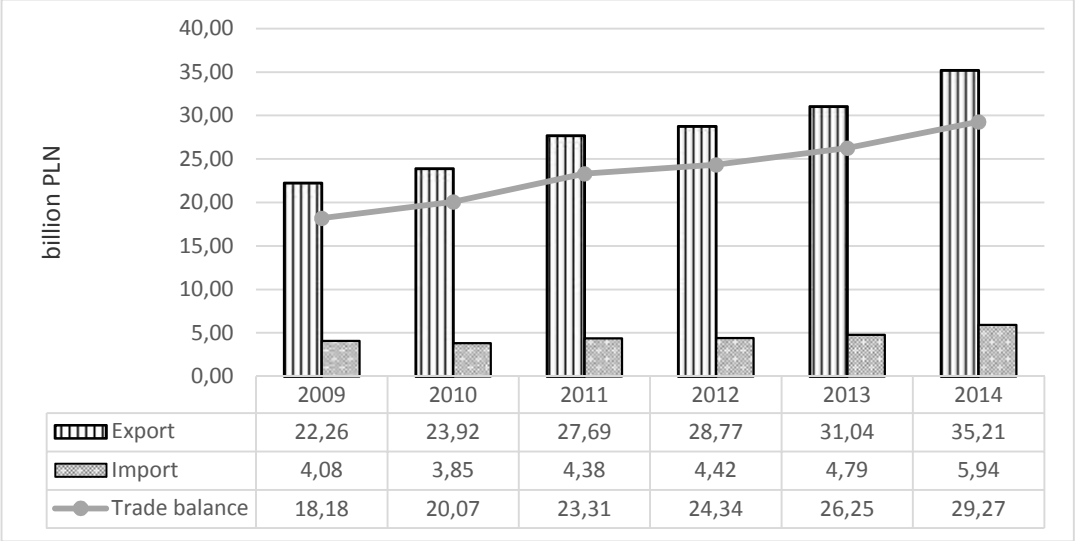
3. REZULTS OF THE STUDIES

According to CSO (GUS) research, in 2009 furniture industry exports amounted to 22.26 billion PLN (figure 1). Till 2014, the increase of furniture value sent abroad was noted year in, year out. The biggest dynamics was observed in 2011 (116%) and in 2014 (113%). Thus, over the six years the value of furniture industry exports increased by as much as 58.2% and in 2014 exceeded 35 billion PLN.

In the analyzed period, the import dynamics was lower and amounted to 45.5%. In 2009 the value of furniture, that appeared from abroad on the Polish market, was estimated at 4.08 billion PLN. At the end of the period the imports value of furniture industry products amounted to 5.94 billion PLN and was nearly by 1/5 ahead of last year. It should also be stressed, that in case of furniture industry the trade exchange generates an extremely high positive trade balance. In the analyzed period, its level increased by 61.0% and in 2014 exceeded 29.2 billion PLN.

Great importance of furniture industry in the trade exchange of Poland is confirmed by the high share of exported furniture value amounting to 5% of the total exports value. This positive trend was

maintained in the whole analyzed period. On the other hand, the share of imported furniture in total imports was much lower and ranged 0.68-0.88%. The large positive trade balance of the furniture market in the face of a deficit in the area of international exchanges of Polish economy, confirms the exceptional export potential of companies from this industry.



	2009	2010	2011	2012	2013	2014
Export	22,26	23,92	27,69	28,77	31,04	35,21
Import	4,08	3,85	4,38	4,42	4,79	5,94
Trade balance	18,18	20,07	23,31	24,34	26,25	29,27

Figure 1. The value of exports, imports and trade balance of Polish furniture industry [billion PLN].
Source: own studies on the basis of Statistical Yearbooks of Foreign Trade from the period 2010-2015.

At the second stage of the analysis a survey was carried out. The characteristic of the researched companies indicates that they have experience on the furniture market. In the first group (I) only 3.1% companies pursued export activities, and 6.7% of companies operate on the domestic market for less than 5 years. Moreover among the export companies, 43.0% of them have run businesses for 10 to 20 years, and every fifth for more than 20 years. In turn, the companies from the second group (II) have operated primarily for 5 to 10 years (40.0%) or for 10 to 20 years (46.7%).

In the first group (I), respondents most frequently pointed to manufacture of case-goods furniture as the basic activity object (figure 2). Every third company indicated this response. A large share in this group were also kitchen (32.3%) and office furniture (27.7%). Almost every fifth respondent from this group pointed to upholstered furniture as a basic activity object, and every tenth - skeletal furniture.

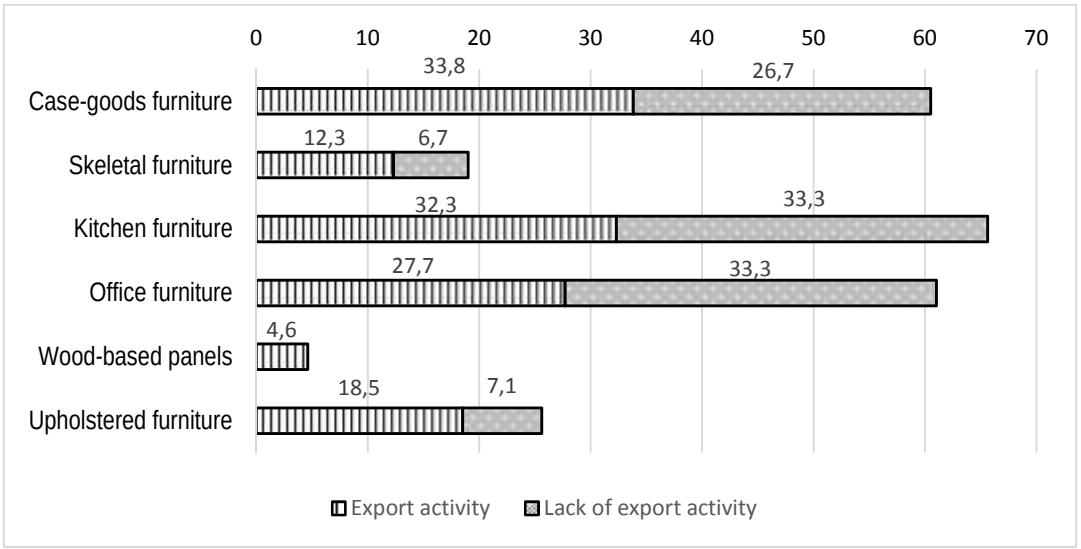


Figure 2. The basic activity object of the surveyed furniture enterprises [%].
Source: own studies.

In the group of companies, that sell products only to the domestic market (II), the most frequently mentioned object of basic activity were kitchen (33.3%) and office furniture (33.3%). Every fifth respondent pointed at case-goods furniture production. On the other hand, 7.1% of respondents indicated upholstered furniture and 6.7% skeletal furniture (figure 2).

The study also included aspects related to the possibility of increasing interest in products offered by furniture manufacturers. In that connection, the group of respondents were asked to identify which of the proposed factors could significantly affect the increase in demand for their products. As a result were received responses, which as the same as above were divided into two group: I and II (figure 3). Findings clearly show that irrespective of conducting or not export activity by the furniture enterprises, the greatest impact to increase the demand for their furniture could be reached owing to reducing the price of the product. 84.6% of respondents from the first group (I) and 86.7% of the second group (II) had such opinion. Other factors, as for which the surveyed companies were also unanimous: achievement the higher quality of products (63.1% answers in the first group (I) and 60% in the second group (II)) and reduction in weight and/or volume of the product (49.2% answers in the first group (I) and 46.7% in the second group (II)).

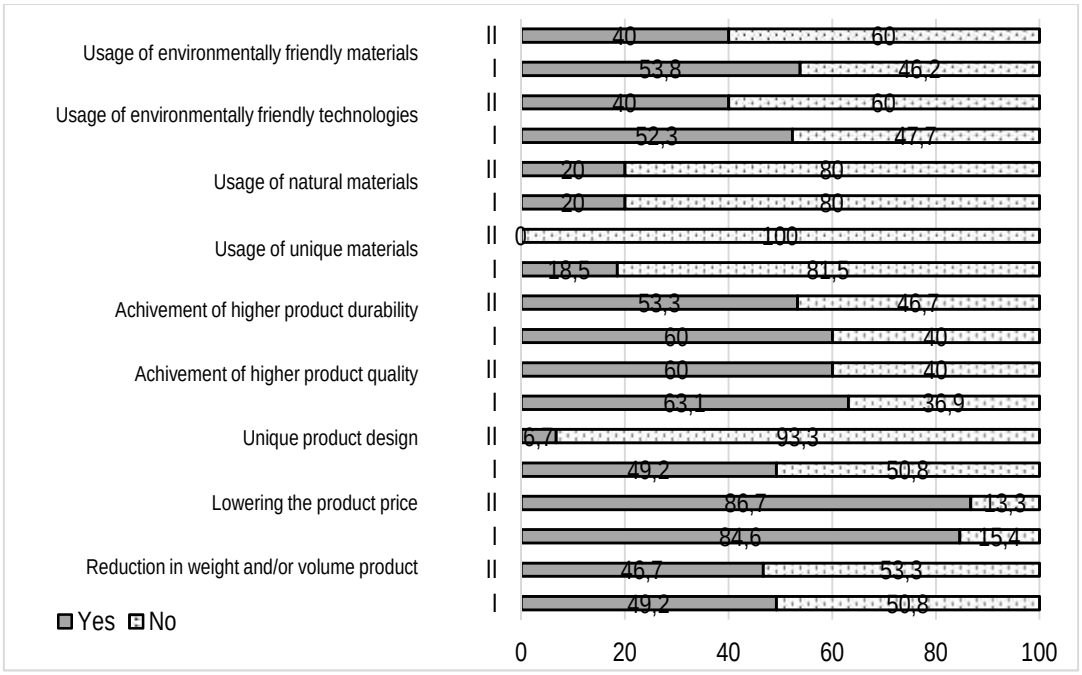


Figure 3. Factors that could significantly affect the increase in demand for the products of the surveyed furniture enterprises [%].
Source: own studies.

Achieving higher durability of the product in the opinion 60.0% of the furniture producers with the first group (I) and 53.3% with the second group (II) would have a positive reflection in increasing interest in their sale offer. Quite surprisingly, respondents assessed the impact of using natural materials for this purpose. Only every fifth respondent from the first (I) and every fifth from the second group (II) consider that usage theirs would have a positive impact on sale. However, as many as 53.8% of the respondents with the first group (I) and 40% of the second (II) decided that the usage of environmentally friendly materials (i.e., not necessarily natural, but probably perceived as less expensive than natural materials) and the usage of environmentally friendly technologies, respectively 52.3% answers in the first group (I) and 40% in the second group (II), affect positively on the increased demand for products. It should also be noted that companies which are not engaged in the export business, i.e. entities in the second group (II), have a much more conservative approach to doing business than companies which sending

products abroad (in the first group - I). This is evidenced by the following findings. Almost 50% of the furniture manufactures in the first group (I) indicated, that the increase in demand for products may be affected by unique product design, which is very strongly associated with the innovativeness. The same opinion on this issue had just 6.7% of respondents from the second group (II). Similar respondents' approach was also noticeable in the next case. The usage of unique materials - 18.5% of respondents in the first group (I) believes that this is the factor that is able to affect growth of products sale. Nevertheless, not a single person from the second group (II) didn't share this view.

70.8% of furniture manufacturers engaged in export activity (the first group - I) confirms that in recent years they have introduced innovative solutions in terms of products or processes. In the group of companies operating only on Polish market (the second group - II) the level of innovativeness was lower. The product or process innovation were implemented by 60.0% of them.

Another aspect that was analyzed in the empirical research refers to fundamental purposes of the implementation of product and process innovations in furniture enterprises (figure 4). In the companies, that undertook the export activity (I), goals of innovation implementation were more diverse, than in the second group (II). Nearly one third of the first group respondents (I) indicated an increase in market share as the primary goal of running innovative activity. Every fifth respondent pointed to the improvement of production efficiency, and every seventh - business cost reduction. In the following places among the main reasons for the implementation of innovative solutions appeared: profit growth and increase in a company value. These answers were indicated respectively by 12.2% and 9.8% of the first group respondents (I). Moreover also nearly 5% of that group considered that shortening a technology process and fulfilment new consumer needs is one of the important objectives of innovation activity. Entry into new markets, compliance with the requirements in terms of technology and increase of company's competitiveness have not been indicated by respondents, regardless of whether the company was involved in export activities or not. In turn, companies that sold their products only on the domestic market (II) pointed at three basic objectives of implementation of product and process innovations. Every second respondent indicated increase in market share, and every fourth - improvement of production efficiency and business cost reduction.

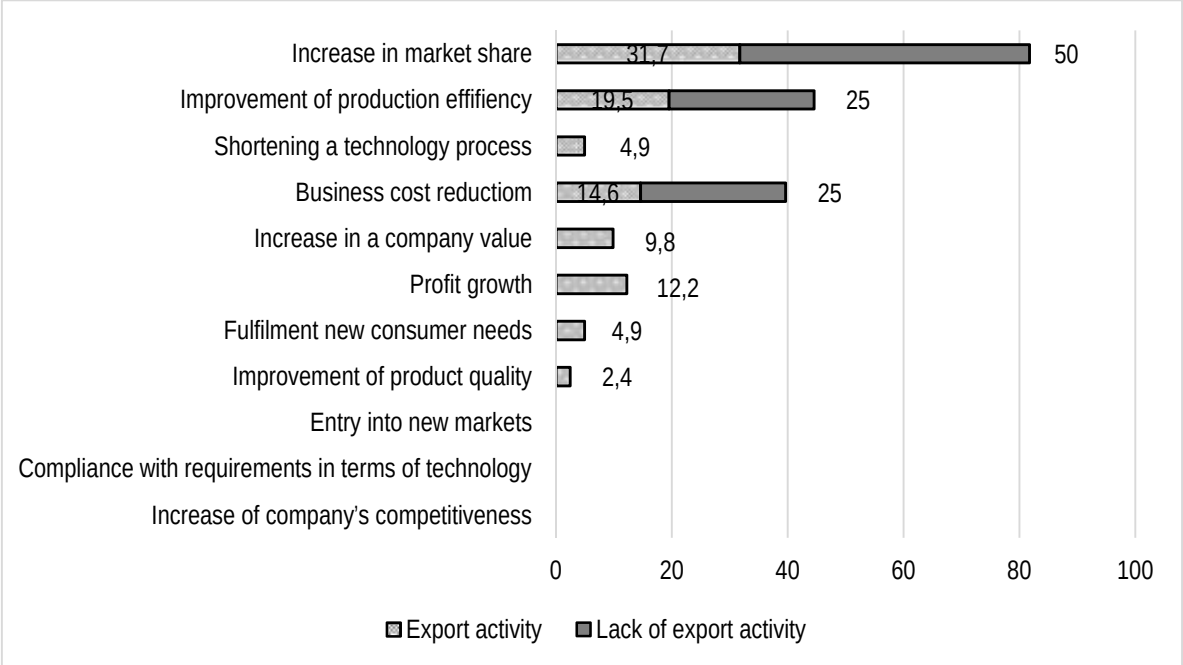


Figure 4. The main objectives of product/process innovation implementation in the surveyed furniture enterprises [%]. Source: own studies.

Conducted research also had in view the recognition of furniture manufacturers' opinion in the range of the barriers to innovation activity. Respondents could indicate maximum 3 from 12 of proposed reasons (table 1). Surveyed manufacturers as the first reason pointed to lack of financial resources. This answer received 46.2% of the furniture exporters' votes and 53.4% of the companies operating only on the domestic market. Entrepreneurs conducting export business (the first group - I) have also mentioned: lack of experience in the area of innovation (13.9%), lack of adequate machine park (12.3%), aversion to take a risk (7.7%) and the low innovation profitability (7.7%). In turn, the producers operating only on the domestic market in addition to the lack of financial resources exchanged: no suitable machine park, lack of experience in the field of innovation and lack of qualified personnel. As the second most frequently mentioned reason was: lack of qualified personnel (indicated by exporters - the first group - I) and lack of financial resources (the company from the second group - II).

Table 1. The main reasons, which greatly restrict of product/process innovation implementation at the surveyed furniture enterprises [%]

Specyfication	The first reason		The second reason		The third reason	
	I	II	I	II	I	II
Aversion to take a risk	7.7	-	9.2	13.3	4.6	13.3
Lack of financial resources	46.2	53.4	16.9	20.0	4.6	-
Lack of adequate machine park	12.3	20.0	3.1		3.1	-
Lack of qualified personnel	9.2	13.3	21.5	13.3	3.1	20.0
Lack of experience in the field of innovation	13.9	13.3	4.6		7.7	6.7
Low innovation profitability	7.7	-	12.3	6.7	4.6	
Small market demand for innovation	-	-	-	-	7.7	13.3
Limited cooperation between science and industry	-	-	6.2	6.7	12.3	6.7
Limited protection of property rights	1.5	-	3.1	6.7	7.7	13.3
Limited knowledge about patents and international standards	-	-	1.5	6.7	3.1	-
Low expenditure on R&D activity	1.5	-	6.2	6.7	-	-
Lack of answers			15.4	20.0	41.5	26.7

Source: own studies.

4. SUMMARY

Polish furniture industry has a unique potential for production and exports. Over the six years the value of furniture industry exports increased by as much as 58.2% and in 2014 exceeded 35 billion PLN. The trade exchange of furniture industry generates an extremely high positive trade balance. In the analyzed period, its level increased by 61.0% and in 2014 exceeded 29.2 billion PLN. Great importance of furniture industry in the trade exchange of Poland is confirmed by the high share of exported furniture value amounting to 5% of the total exports value.

Conducted studies have shown, that companies not engaged in the export business, have a much more conservative approach to doing business than companies that conduct such activities. In recent years 70.8% of surveyed furniture manufacturers engaged in export activity (the first group - I) have introduced innovative solutions in terms of products or processes. In the group of companies operating only on Polish market (the second group - II) the level of innovativeness was lower. The product or process innovation were implemented by 60.0% of them. Almost 50% of the furniture manufactures from

the first group (I) indicated, that the increase in demand for products may be affected by unique product design, which is very strongly associated with the innovativeness. The same opinion on this issue had just 6.7% of respondents from the second group (II). Similar respondents' approach was also noticeable in the next case – the usage of unique materials. 18.5% of respondents in the first group (I) believes that this is the factor that is able to affect growth of products sale. Nevertheless, not a single person from the second group (II) didn't share this view.

However, exporters and non-exporters motivation to innovate is similar. In companies that undertook export activities (I) almost every third respondent pointed to an increase in market share as the primary goal of making innovative activity, and among the non-exporters (II) - every second. Subsequently, every fifth respondent from the first group (I) indicated the improvement of production efficiency, and every seventh - reduction of the business cost. Among surveyed companies, that sell their products only on the domestic market (II), in both cases answered in that way every fourth respondent. Entry into new markets, compliance with the requirements in terms of technology and increase of company's competitiveness have not been indicated by respondents, regardless of whether the company was involved in export activities or not.

Findings clearly show that the greatest impact to increase the demand for their furniture could be reached owing to reducing the price of the product. 84.6% of respondents from the first group (I) and 86.7% of the second group (II) had such opinion. In the next places were mentioned: achievement a higher quality of products (63.1% of answers in the first group - I and 60% in the second group - II) and reduction of the weight and/or volume of the product (49.2% of answers in the first group - I and 46.7% in the second - II). Quite surprisingly respondents assessed the impact of using natural materials in the products which is offered to consumer. Only every fifth respondent from the first (I) and every fifth from the second group (II) consider that usage theirs would have a positive impact on sale. However, as many as 53.8% of the respondents with the first group (I) and 40% of the second (II) decided that the usage of environmentally friendly materials (i.e., not necessarily natural, but probably perceived as less expensive than natural materials) and the usage of environmentally friendly technologies, respectively 52.3% answers in the I group and 40% in the II group, affect positively on the increased demand for products.

Summing up, these findings suggest that irrespective of conducting export activities or not, Polish furniture manufacturers perceive the development opportunity of their companies in the effective implementation of the low - price strategy. The exporters, more than non-exporters, are willing to bear more risk and are more receptive to benefit from new technology solutions and innovation implementation. They are also more aware of the opportunities to achieve their measurable benefits in the future. Therefore, it can be argued that the furniture manufacturers, who export their products, will develop faster than those companies that operate only on the domestic market.

Acknowledgements:
Research was carried out under development project Implementation of Eco-glueing innovative technology of composite materials veneered asymmetrically, used in furniture production (No. TANGO1/266389/NCBR/2015) financed by The National Centre for Research and Development

REFERENCES

1. Cao X., Hansen E. [2006]: Innovation in China's furniture industry. Forest Products Journal November – December 56[11/12]: 33 – 42
2. Grzegorzewska E., Więckowska M., Efficiency ratios in furniture industry in the face of the global economic crisis, Annals of Warsaw University of Life Sciences - SGGW. Forestry and Wood Technology 2013, No. 82: 298-302

3. Grzegorzewska E., Stasiak-Betlejewska R. [2014]: The Influence of Global Crisis on Financial Liquidity and Changes in Corporate Debt of the Furniture Sector in Poland. DrvnaIndustrija 65 [4], 315-322 DOI:10.5552/drind.2014.1342
4. Grzegorzewska E., The influence of global economic crisis on import and export of furniture in Poland, Annals of Warsaw University of Life Sciences - SGGW. Forestry and Wood Technology 2013, No. 82: 308-312
5. Kusumawardhani A., McCarthy, G. [2013]: Innovation in small and medium-sized wood furniture firms in Central Java, Indonesia. International Conference on Managing the Asian Century, Singapore: 1 – 11
6. Petter R. R., Resende L. M., Júnior P. P. [2013]: Comparative analysis on the adoption of innovation in furniture companies. Independent Journal of Management & Production January – June 4[1]: 111 – 125 DOI: 10.14807/ijmp.v4i1.60
7. Pérez-Luño A., Cabrera R. V., Wiklund J. [2007]: Innovation and imitations as sources of sustainable competitive advantage. Management Research 27(2): 216 – 232 http://dx.doi.org/10.2753/JMR1536-5433050201
8. Polish Chamber of Commerce of Furniture Manufacturers (OIGPM), B+R Studio: Polish Furniture Outlook 2015
9. Smardzewski J. [2009]: The Polish furniture industry – a vision of the future. Drewno – Wood 52[182]: 103 – 114
10. Central Statistical Office (GUS): Statistical Yearbook of Foreign Trade 2010, Warsaw 2011
11. Central Statistical Office (GUS): Statistical Yearbook of Foreign Trade 2011, Warsaw 2012
12. Central Statistical Office (GUS): Statistical Yearbook of Foreign Trade 2012, Warsaw 2013
13. Central Statistical Office (GUS): Statistical Yearbook of Foreign Trade 2013, Warsaw 2014
14. Central Statistical Office (GUS): Statistical Yearbook of Foreign Trade 2014, Warsaw 2015
15. Central Statistical Office (GUS): Statistical Yearbook of Foreign Trade 2015, Warsaw 2016
16. Szostak A., Ratajczak E. [2009]: Results of the innovation activity of the wood sector. Drewno – Wood 52[182]: 123 – 129

Authors address:
Grzegorzewska Emilia *[1]; Więckowska Magdalena [2]
[1] Department of Technology and Entrepreneurship in Wood Industry, Faculty of Wood Technology, Warsaw University of Life Sciences (SGGW), Warsaw, Poland
[2] Faculty of Forestry in Hajnówka, Bialystok University of Technology (PB), Bialystok, Poland

*Corresponding author: emilia_grzegorzewska@sggw.pl

EUROPEAN ECO LABELS FOR WOOD FLOORING

Petrović, S.

ABSTRACT

Due to its multiannual use and large surface on which it is placed, wood flooring has an exceptional impact on the health of people who spend time in the rooms in which it is placed. Because of this, materials containing cancerous and mutagenic substances or agents which have high emissions of volatile organic compounds (VOC emissions) during their use must not be used for flooring production. In order to prove that wood flooring does not have a harmful effect on the environment or human health during the use, adequate eco certifications have been created in previous decades. In Europe, the following eco certifications are mostly used for this product type: Nordic Swan, German Blue Angel and Natureplus, Austrian UZ and EU eco certification.
Keywords: wood flooring, eco certification, coating materials, adhesives, VOC emissions

1. INTRODUCTION

Because of the expressed impact of wood flooring on the health of persons who spend time in the rooms in which it is placed, environmental features of these products have become an important feature of their quality in recent years. Regarding this, the requirements for wood flooring are to be made of the materials which have extremely low VOC emissions later during the use. This primarily refers to the materials used for wood flooring production such as adhesives, coating materials, putty, as well as the materials used when laying the flooring. Beside VOC emissions, requirements for obtaining eco certificates precisely define which types of substances the materials for wood flooring production must not contain because they have harmful effect on human health.

Wood flooring products are used in closed spaces thus their characteristics have impact on the quality of atmosphere conditions in the room in which they are used. Very often, VOC emissions which appear in closed space are characterized by smells of certain intensity. This characteristic of wood flooring is presently tested only for Natureplus certification, however it is expected to become a mandatory request for other eco certifications very soon. Regarding this, new European standard titled DIN ISO 16000-28 (2012): Indoor air – Determination of odour emissions from building products using test chambers, will have an increasing significance in the upcoming period for the obtaining of eco labels.

2. MATERIAL AND METHODS

Documents in which the requirements for Nordic, German, Austrian and EU certification are stated were used for analysing the most significant eco labels used in Europe. Since certification procedures are always based on the relevant standards for particular product type which is being certified, certain European standards were also analysed as well. Also, contents of certain European Union regulations were used.

Research the results of which are presented in the paper was conducted by using the method of analysis, namely analysis of content and comparative analysis. Method of content analysis was used for the purpose of understanding the documents which set the requirements for eco certifications and for determining the most significant characteristics of the analysed eco labels, while comparative analysis was used for determining the similarities and differences among them. Adequate conclusions for the research topic presented in the paper were made by using general scientific methods of induction and deduction.

3. RESEARCH RESULTS AND DISCUSION

The most significant eco labels for wood flooring used in Europe are analysed in the paper which are: Nordic Swan, German Blue Angel and Natureplus, Austrian UZ and EU label EU. All analysed eco labels represent type I eco labels, which means that they are issued pursuant to the requirements of the standard ISO EN 14024 (1999): Environmental labels and declarations - Type I environmental labelling - Principles and procedures. This standard specifies the testing of those product characteristics which have impact on the environment, such as toxicity, recyclability and determination of percentage of energy from renewable sources used for their production. Certification body awards type I eco label by issuing certificate for using this label.

Beside eco labels, certain quality classification systems for construction products used for the production and laying of wood flooring are also analysed in the paper, which are conducted only based on the values of VOC emissions.

3.1. The main characteristics of the analysed European eco labels for wood flooring

According to the requirements of the Nordic, German, Austrian and EU certification, the following types of wood flooring can obtain the eco label: parquet, solid wood flooring (with tongues and grooves and without tongues and grooves), laminate flooring, veneer flooring, bamboo flooring and cork flooring. According to German Blue Angel and Austrian certification bamboo and cork flooring are not considered as wood flooring. Pursuant to the requirements of the Natureplus certification, only parquet, solid wood flooring and veneer flooring are considered as wood flooring.

Eco certified wood flooring has to be produced, classified and tested pursuant to the following reference standards:

- the following are used for parquet and solid wood flooring: EN 13226 (2009): Wood flooring - Solid parquet elements with grooves and/or tongues, EN 13227 (2002): Wood flooring - Solid lamparquet products, EN 13228 (2011): Wood flooring – Solid wood overlay flooring elements including blocks with an interlocking system, EN 13488 (2005): Wood flooring – Mosaic parquet elements, EN 13489 (2005): Wood flooring - Multi-layer parquet elements, EN13696 (2008): Wood flooring – Test methods to determine elasticity and resistance to wear and impact resistance and EN 14342 (2014): Wood flooring and parquet - Characteristics, evaluation of conformity and marking;
- the following are used for laminate flooring: EN 14041 (2004): Resilient, textile and laminate floor coverings - Essential characteristics, ISO 10874 (2009): Resilient, textile and laminate floor coverings -- Classification, EN 13329 (2016): Laminate floor coverings - Elements with a surface layer based on aminoplastic thermosetting resins - Specifications, requirements and test methods, EN 14978 (2016): Laminate floor coverings - Elements with acrylic based surface layer, electron beam cured - Specifications, requirements and test methods, EN 15468 (2016): Laminate floor coverings - Elements with directly applied printing and resin surface layer - Specifications, requirements and test methods;
- the following is used for cork flooring: EN 12104 (2000): Resilient floor coverings -- Cork floor tiles -- Specification, and for
- veneer flooring: EN14354 (2004): Wood-based panels - Wood veneer floor covering.

Since the relevant European standards for wood flooring are harmonized with the Construction Products Regulation 305/2011/EU-CPR, it implies that wood flooring holds CE mark which is a precondition for eco certification too.[8] On German market, wood flooring must also have the national Ü

[8] During the testing for issuing CE mark for wood flooring, emission of formaldehydes, pentachlorophenol, tensile strength and fire reaction are determined.

conformity mark, in addition to the CE mark. This conformity mark is used only on the market in Germany and it has been mandatory for laminate flooring from 2005 and for parquet and wood flooring from 2011.[9]

Generally, requirements which wood flooring has to fulfil in order to obtain eco label can be divided into three groups. The first group of requirements refers to wood raw material for flooring production, the second group refers to the chemical characteristics of the agents used for their production and laying and the third refers to the consumption of energy in flooring production.

3.1.1. Requirements of raw materials used for the production of eco certificated wood flooring

According to the requirements of the analysed eco certifications, the first condition which wood flooring has to fulfil to obtain the eco label is to be produced from the certified wood raw material. Pursuant to the requirements of Nordic and EU certification, at least 70% of wood raw material for flooring production has to originate from the FSC/PEFC certified forests (40% for wood-based products according to the EU certification), while pursuant to the requirements of German and Austrian certification this percentage amounts to 50% (Nordic Ecolabelling of Floor coverings; Wooden floor coverings: EU ecolabel award scheme; RAL-UZ 176; Richtlinie UZ 56). EU eco label can be obtained for wood flooring, laminate flooring and cork and bamboo flooring if more than 90% of their mass is of wood, wood flour and/or wooden/herbaceous material (Wooden floor coverings: EU ecolabel award scheme). The condition for obtaining Naturplus eco label is that at least 95% of wood flooring has to be produced from renewable raw material (For the Awardance of the Eco-Label - Award Guideline 0209).

Additional condition for wood raw material set only in the requirements of the German certification is that flooring producer has to prove the legality of its origin pursuant to the European Union regulation EUTR 995/2010.

Nordic certification has the strictest requirements for raw material used for flooring production. This eco certification is specific because it sets that flooring produced from certain wood species cannot obtain eco label. Regarding this, flooring produced from wood species on the CITES list and IUCN[10] red list, or if raw material originates from the forests managed in unsustainable manner, cannot be subject to the Nordic eco certification (Nordic Ecolabelling of Floor coverings).[11]

Prohibition of using GMO wood for wood flooring production is present only in the requirements of the EU certification. Requirements of the EU and Nordic certification set that wood (including bamboo) used for flooring production, shall not be treated with pesticides after logging, which according to the classification of the World Health Organization belong to Ia class and are defined as extremely dangerous and to Ib class and are defined as very dangerous (Nordic Ecolabelling of Floor coverings, Wooden floor coverings: EU ecolabel award scheme).[12]

According to the requirements of these two certifications, flooring producer has to make a management plan for wood waste which occurs during flooring production and to define in it the amount and type of waste which occurs, manner for its disposal and the potentials for its reuse.

3.1.2. Chemical characteristics of the agents used for the production of eco certified wood flooring

Testing of wood flooring includes the analysis of the presence of carcinogenic (H350), mutagenic (H340) and toxic substances (H360) of category 1 or 2, according to the classification given in the table

[9] Use of flooring without Ü conformity mark on the market in Germany is considered a criminal act. Key difference between the products with CE and Ü mark is that the products with Ü mark must have information about the application, measures and design defined in national regulation in addition to the information about properties.

[10] IUCN - International Union for the Conservation of Nature and Natural Resources.

[11] List of wood species the produced flooring of which cannot be eco certified pursuant to the Nordic requirements can be found on the website: http://www.nordic-ecolabel.org/wood/

[12] World Health Organization: http://www.who.int/ipcs/publications/pesticides_hazard_2009.pdf.

3.2 of the Annex VI of the European Union Directive EC No 1272/2008[13], i.e. of category 1A or 1B according to the classification given in the table 3.1. in the same document (table 1). These substances are present in wood flooring only if adhesives, coating materials and similar materials containing these substances are used for its production.

Table 1. List of hazardous substances whose presence in wood flooring is tested according to the requirements of Nordic, EU and Naturplus eco certification

Hazard class and category	Hazard category and hazard phrase in line with CLP Regulation
Toxic to aquatic organisms Category Acute 1 Chronic 1-2	H400 – Very toxic to aquatic life. H410 – Very toxic to aquatic life with long lasting effects. H411 – Toxic to aquatic life with long lasting effects. H412 – Harmful to aquatic life with long lasting effects.
Hazardous to the ozone layer	EUH059 – Hazardous to the ozone layer.
Acute toxicity Category 1-3	H300 – Fatal if swallowed. H310 – Fatal in contact with skin. H330 – Fatal if inhaled. H301 – Toxic if swallowed. H311 – Toxic in contact with skin. H331 – Toxic if inhaled.
Specific target organ toxicity (STOT) with single and repeated exposure: - STOT SE category 1-2 - STOT RE category 1-2	H370 – Causes damage to organs. H371 – May cause damage to organs. H372 – Causes damage to organs. H373 – May cause damage to organs.
Carcinogenic Carc 1A/1B/2	H350 – May cause cancer. H350i – May cause cancer by inhalation. H351 – Suspected of causing cancer.
Mutagenic Mut 1A/B/2	H340 – May cause genetic defects. H341 – Suspected of causing genetic defects.
Toxic for reproduction Repr 1A/1B/2	H360 – May damage fertility or the unborn child. H361 – Suspected of damaging fertility or the unborn child. H362 – May cause harm to breast-fed children.

Sources: 1. Nordic Ecolabelling of Floor coverings; 2. For the Awardance of the Eco-Label - Award Guideline 0209; 3. Wooden floor coverings: EU ecolabel award scheme.

Beside the stated in table 1, according to the requirements of German Blue Angel and Austrian UZ eco certification, the presence of the substances stated in table 2 in wood flooring is also tested.

According to the requirements of the analysed eco certifications, eco certified wood flooring must not have emissions of VOC, formaldehydes and ammonia (originating from the agents used for flooring production) higher than the values stated in table 3. Limit values for Nordic, German and Austrian certification are quite similar, while the values for the EU certification are defined after three days of testing because of which it is not possible to make comparison with the values of other certifications.[14]

[13] Regulation (EC) No1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No1907/2006, Annex VI Harmonized classification and labelling for certain hazardous substances, Part 3: Harmonized classification and labelling (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF).

[14] Significant number of certifications of construction products, as well as obtaining the U conformity mark in Germany is based on the requirements set in the AgBB evaluation scheme of the German Federal Environment Agency; http://www.eco-institut.de/en/home/detail/agbb-scheme-2015-published-with-new-lci-values-applying-also-for-vvoc-and-svoc/

Table 2. Supplementary list of substances whose presence is tested in wood flooring during eco certification

Hazard class and category	Hazard category and hazard phrase in line with CLP Regulation 1272/2008
Toxic to aquatic organisms Category Acute 1 Chronic 1-2	H413 – May cause long lasting harmful effects to aquatic life.
Acute toxicity Category 1-3	H317 – May cause an allergic skin reaction. H334 – May cause allergy or asthma symptoms or breathing difficulties if inhaled.
Toxic for reproduction Repr 1A/1B/2	H360F – May damage fertility. H360D – May damage the unborn child. H360FD – May damage fertility. May damage the unborn child. H360Fd – May damage fertility. Suspected of damaging the unborn child. H360Df – May damage the unborn child. Suspected of damaging fertility. H361f – Suspected of damaging fertility. H361d – Suspected of damaging the unborn child. H361fd – Suspected of damaging fertility. Suspected of damaging the unborn child.

Sources: 1. Richtlinie UZ 56; 2. RAL-UZ 176.

Table 3. Values of VOC emissions for wood flooring according to the requirements of Nordic, German, Austrian and EU certification

Compound or Substance	Limit values of emissions in mg/m^3				
	After 28 days				After 3 days
	Nordic certification	Blue Angel certification	Austrian certification	Natureplus certification	EU certification
Total organic compounds within the retention range of C6 to C16 (TVOC)	≤ 0.3	≤ 0.3	≤ 0.3	≤ 0.3	≤ 0.25
Total organic compounds within the retention range of > C16 to C22 (TSVOC)	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.03
Total VOC without LCI (LCI - Lowest Concentration of Interest)	Not definite	≤ 0.1	≤ 0.1	Not definite	≤ 0.05
Ammonia	--	0.1	--	--	--
Formaldehyde (values expressed in parts per million - ppm)	≤ 0.06 ppm	≤ 0.05 ppm	≤ 0.05 ppm	Solid wood flooring: ≤ 0.03 ppm Glue laminated flooring: ≤ 0.04 ppm	≤ 0.05 ppm

Sources: Nordic Ecolabelling of Floor coverings; 2. For the Awardance of the Eco-Label - Award Guideline 0209; 3. Wooden floor coverings: EU ecolabel award schemel; 4. RAL-UZ 176; 5. Richtlinie UZ 56.

Apart from VOC emissions, testing of the presence of certain chemical elements in wood flooring is also tested with the following allowed values: for arsenic, chromium and lead by 5mg/kg, for cadmium 0,5 mg/kg, for cobalt 100 mg/kg, for copper 20 mg/kg, for mercury 0,1 mg/kg, for nickel 10 mg/kg, and for antimony 1 mg/kg (For the Awardance of the Eco-Label - Award Guideline 0209). If the flooring

consists of particleboards or fibreboards, allowed values of certain chemical elements in these boards are the following: for arsenic, beryllium, cobalt, nickel, antimony and zirconium by 1 mg/kg, boron 25 mg/kg, cadmium 0,5 mg/kg, chromium 2 mg/kg, copper and lead by 10 mg/kg and mercury 0,1 mg/kg (For the Awardance of the Eco-Label - Award Guideline 0209).

According to the requirements of the analysed certifications, most often the use of the following is not allowed for the production of wood flooring:

- substances on the Candidate List[15],
- persistent, bioaccumulative and toxic (PBT) organic substances, very persistent and very bioaccumulative (vPvB) organic substances[16],
- substances considered to be potential endocrine disruptors in category 1 or 2 on the EU's priority list of substances that are to be investigated further for endocrine disruptive effects[17],
- alkylphenol ethoxylates and other alkylphenol derivatives, halogenated organic substances (organic chloroparaffins, flourine compounds and halogeneated fire retardants), phthalates, aziridine and polyaziridines,
- pigments and additives based on lead, tin, cadmium, chromium VI and mercury, or compounds of these and
- pesticides (organochlorine and organophosphate pesticides and pyrethroids) (Nordic Ecolabelling of Floor coverings).

Requirements of the Natureplus eco certification set that the intensity of smell of the placed wood flooring shall be ≤3,[18] while the requirements of the German Blue Angel certification only recommend the producers to test smell intensity for their products (For the Awardance of the Eco-Label - Award Guideline 0209).

3.1.3. Energy consumption for wood flooring production

Determination of energy consumed for the production of wood flooring is defined only in Nordic and EU certification. According to the requirements of both certifications, calculation for consumed energy is conducted on annual level after which its annual average is determined.

According to the requirements of the Nordic certification, at least 95% of used raw material has to be included in the calculation, where energy consumed for the production of wood-based panels used for flooring production is also calculated, however energy consumed for the production of adhesives and varnishes are not calculated. Total amount of consumed energy for wood flooring production is calculated by using the following formula according to the requirements of this certification:

$$E = A/20 + (5 – B/3) + (5 – C/7)$$

Where is:

A – proportion of renewable fuel (%); B – electricity consumption (maximum 15 KWh/m^2); C – fuel consumption (maximum 35 kWh/m^2) (Nordic Ecolabelling of Floor coverings).

E should be at least 11 for solid wood flooring, 8 for parquet, laminate flooring, bamboo flooring and cork flooring (Nordic Ecolabelling of Floor coverings).

When calculating the consumed energy pursuant to the requirements of the EU certification, certified raw material and recycled material used for flooring production are taken into consideration, as well as the consumed amounts of electricity and fuel. Calculation of the consumed energy includes all activities for which the energy was consumed from the moment when the raw material entered the factory

[15] Candidate List of Regulation (EC) No. 1907/2006 concerning the Registration, Evaluation, Authorization, and Restriction of Chemicals: http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp

[16] PBT and vPvB substances are defined in Annex XIII of Regulation EC No 1907/2006. Substances that meet, or substances that form substances that meet, the PBT or vPvB criteria are listed at http://esis.jrc.ec.europa.eu/index.php?PGM=pbt.

[17] http://ec.europa.eu/environment/chemicals/endocrine/pdf/final_report_2007.pdf.

[18] The scale used for evaluating the smell pursuant to the requirements of the Natureplus eco certification has 6 grades, and smell intensity is evaluated 24h after the filling of the test chamber.

premises to the last operation on the final product, including packing. The calculation does not include energy consumed for the production of raw material, or for the production of adhesives and coating materials. Depending on flooring type, formulas for calculating consumed energy have the following forms:

- for solid wood flooring and bamboo flooring: $P = A/25 + B/25 + (4-0,055xC) + (4-0,022xD) > 10,5$

Where is: A - Wood from certified, sustainable forest (%); B - Proportion of renewable fuels (%); C - Electricity consumption (MJ/m^2); D - Fuel consumption (MJ/m^2);

- for laminate flooring: $P = A/25 + B/25 + C/25 + (4-0,055xD) + (4-0,022xE) > 12,5$

Where is: A - Cork, bamboo or wood from certified forest (%); B - Proportion of recycled wood raw materials (%); C - Proportion of renewable fuels (%); D - Electricity consumption (MJ/m^2); E - Fuel consumption (MJ/m^2);

- for cork flooring: $P = A/25 + B/25 + (4-0,055xC) + (4-0,022xD) > 9$

Where is: A - Proportion of recycled cork (%); B - Proportion of renewable fuels (%); C - Electricity consumption (MJ/m^2); D - Fuel consumption (MJ/m^2) (Wooden floor coverings: EU ecolabel award scheme).

3.1.4. Declaration on the packaging of eco certified wood flooring

Most often, the following information is stated on the packaging of certified wood flooring:

- logo of eco label and data about flooring producer (figure 1);
- product name and material (mark and origin of dominant wood species used in flooring production);
- colour/model and lot number (and wear class only for laminate flooring);
- dimensions of parquet elements and floor surface in one packaging expressed in m^2;
- instructions for storage and disposal;
- instructions for laying and recommendations for using certain types of adhesives for joining the elements of wood flooring, as well as for their gluing to the subfloor below the wood flooring;
- instructions for coating treatments for flooring without surface coating (type/amount of oil or varnish with low emission);
- instructions for cleaning, maintenance, disposal, separation of flooring when it is moved to another location, recycling, extending the lifespan of flooring by renovating, i.e. sanding and recoating.

According to the requirements of the analysed certifications, material for packing the flooring should be recyclable. Plastic packaging for eco certified wood flooring must be polyolefin based. Also, packaging material must not contain biocides.

Figure 1. Logo of Nordic eco label Swan, German Blue Angel and Nature plus, Austrian UZ and European EU (Source:1. http://www.nordic-ecolabel.org/; 2. https://www.blauer-engel.de/en; 3. http://www.natureplus.org/; 4. https://www.umweltzeichen.at/cms/en/austrian-ecolabel/vision/content.html; 5. http://ec.europa.eu/environment/ecolabel/)

German Blue Angel certification is specific for not allowing any commercial messages on the packaging of certified flooring, such as: “no negative impact on the environment” or “products are not toxic” or “not dangerous for health”. Also, it is not allowed to use marks such as organic, eco and similar (RAL-UZ 176).

3.2. Classification of construction material according to the VOC emissions

Beside eco certification for which the products have to fulfil various types of requirements, system of quality classification for construction material has been used in the last two decades in Europe based on the VOC emissions. Application of this system promotes the production and use of construction material with low emission which results in healthier and more comfortable conditions for human presence in the rooms in which it is used. The first such classification system was introduced in 1995 in Finland as a part of classification system for air and closed space atmosphere, which is why the intensity of smell of volatile organic compounds from construction materials is also taken into consideration in this classification system. According to this classification system, construction materials are divided into three classes, where materials of M1 class have the lowest emissions and materials of M3 class have the highest emissions (figure 2). According to the requirements of classification, levelling agents, putty, mastics, fillers and screeds must not contain casein.[19] Requirements for emissions set in this classification system are one of the strictest in Europe (table 4).

Figure 2. Logo for M1 quality class for construction products (Source: http://m1.rts.fi/en/)

Table 4. Values of VOC emissions according to the Finnish classification system

Criteria/classification	Limit values of emissions after 28 days of testing		
	M1 (mg/m²h)	M2 (mg/m²h)	M3 (mg/m²h)
TVOC (Minimum of 70% of the compounds shall be	< 0.2	< 0.4	> 0.4
Formaldehyde	< 0.05	< 0.125	> 0.125
Ammonia	< 0.03	< 0.06	> 0.06
Carcinogenic compounds	< 0.005	< 0.005	
Odour (dissatisfaction with odour shall be below 15%)	No odour	No odour	Odour

Source: http://m1.rts.fi/en/m1-criteria-and-the-use-of-classified-products-2d03887d-aa6a-4a66-ad3c-ce25a512cf38

Similar quality classification system for construction products, adhesives, materials used when laying wood flooring and its surface coating exists in Germany as well from 1997. According to the requirements of the GEV EMICODE® classification, construction materials are grouped into three classes based on VOC emission, where classes EC 1PLUS and EC1 are characterized by very low emissions and class EC2 are characterized by low VOC emissions (figure 3). Values of emissions of volatile organic compounds, formaldehydes, acetaldehydes for each quality class pursuant to the GEV EMICODE® classification are given in table 5.

Figure 3. Logo for GEV EMICODE® quality class of construction products (Source: http://www.emicode.com/en/emicode-r/categories/)

Table 5. Quality classes for construction products according to the GEV EMICODE® system

	EC 1PLUS	EC1	EC2
	µg/m³		
TVOC after 28 days	≤ 0.06	≤ 0.1	≤ 0.3
TSVOC after 28 days	≤ 0.04	≤ 0.05	≤ 0.1
Sum non-assessable VOC	≤ 0.04	-	-
Formaldehyde after 3 days	≤ 0.05	≤ 0.05	≤ 0.05
Acetaldehyde after 3 days	≤ 0.05	≤ 0.05	≤ 0.05
Sum formaldehyde and acetaldehyde	≤ 0.05 ppm	≤ 0.05 ppm	≤ 0.05 ppm

[19] http://m1.rts.fi/en/m1-criteria-and-the-use-of-classified-products-2d03887d-aa6a-4a66-ad3c-ce25a512cf38

Any C1A/C1B VOC after 28 days	≤ 0.001	≤ 0.001	≤ 0.001

Source: http://www.emicode.com/en/emicode-r/limit-values/

4. CONCLUSION

Considering that it is laid on large surfaces and that its lifespan is long, wood flooring can have significant impact on the health of people who spend time in the areas in which it is used. This impact can be unfavourable if the flooring is produced from the materials containing hazardous substances or if it has high VOC emissions with intensive odour during its use. Consumers should select eco certified products in order to be sure that wood flooring which they bought will not have harmful effect on their health or environment during its use. Nordic Swan, German Blue Angel and Naturplus, Austrian UZ and EU label are the best known eco labels used in Europe for wood flooring. In order to get eco label, wood flooring has to fulfil certain requirements regarding wood raw material it is made of, values of VOC emissions originating from the materials used for its production and the amount of energy consumed for its production.

Note: The paper is financially supported by the Ministry of Science and Technological Development of the Republic Serbia within the project ref.43007: „Research of climate changes and their environmental impact – monitoring of impacts, adaptation and mitigation“.

REFERENCES

1. ***: For the Awardance of the Eco-Label - Award Guideline 0209: Wood and Wood-Based Flooring (2015):The International Association for Future-Oriented Building and Accommodation, http://www.natureplus.org/fileadmin/user_upload/pdf/cert-criterias/GL0209.pdf, accessed on: 17.05.2016.
2. ***: Harmonisation of indoor material emissions labelling systems in the EU, Report No 24 (2005): European Commission, Directorate Joint Research Centre, Institute for Health and Consumer Protection, Italy, ISBN: 92-79-01043-3, http://www.buildingecology.com/publications/ECA_Report24.pdf, accessed on: 01.07.2016.
3. ***: Nordic Ecolabelling of Floor coverings, Version 6.1, 18 November 2014 - 31 December 2019, The Nordic Council of Ministers, http://www.svanemerket.no/PageFiles/12197/029_Background_to_proposed_criteria_version_6.pdf, accessed on: 16.05.2016.
4. ***: RAL-UZ 176: Basic Criteria for Award of the Environmental Label - Low-Emission Floor Coverings, panels and Doors for Interiors made of Wood and Wood-Based Materials (2013): RAL gGmbH, Germany, http://www.eco-institut.de/fileadmin/contents/Nationale_Pruefzeichen/BlauerEngel/176-1301-e.pdf, accessed on: 16.05.2016.
5. ***: Regulation EC No1272/2008 on classification, labelling and packaging of substances and mixtures, of the European Parliament and of the Council; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF, accessed on: 16.06.2016.
6. ***: Richtlinie UZ 56: Fußbodenbeläge Version 3.0 (2015): Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Austria, www.umweltzeichen.at/richtlinien/UZ56_R3.0a_Fu%C3%9Fbodenbel%C3%A4ge_2015.pdf, accessed on: 16.05.2016.
7. ***: Wooden floor coverings: EU ecolabel award scheme - User manual (2010): http://ec.europa.eu/environment/ecolabel/documents/User_manual_wooden_covering.pdf, accessed on: 24.05.2016.
8. ***: Standard EN 14342 (2014): Wood flooring and parquet – Characteristics, evaluation of conformity and marking, CEN, Brussels

Author address:
DSc. Slavica Petrović, assistant professor, Department for Technology, Management and Design of furniture and wood products, Faculty of Forestry, University of Belgrade, 11030 Belgrade, Serbia, e-mail: slavica.petrovic@sfb.bg.ac.rs


FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

SURVEY OF CHAIN OF CUSTODY CERTIFICATION IN THE COUNTRIES OF CENTRAL AND SOUTH EUROPE

Paluš H.; Parobek J; Vlosky P. R; Motik D.; Oblak L.; Jošt M.; Glavonjić B.; Dudík R.; Wanat L.

ABSTRACT

The aim of this paper is to examine the conditions in the chain of custody certification in the region of the Central and South Europe. A multinational survey involving chain of custody certificates holders in Slovakia, Czech Republic, Poland, Slovenia, Croatia and Serbia was conducted to identify the understanding of the concept of forest certification as environmental, economic and social tool and to determine incentives for its implementation by companies. Results indicate that surveyed companies demonstrated a high level of understanding of the chain of custody certification concept. However, they link forest certification mainly to the issues of legality, tracing the origin source of supply and prevention from illegal logging. The main expected benefits following from certification are those of improvement of external company image followed by business performance factors such as penetrating new markets, increase of sales volume, expanded market share and the increase of profit margin.
Key words: forest certification, chain of custody, timber legality

1. INTRODUCTION

The idea of sustainable forest management is based on the concept of sustainable development and leans on three integrated and equally important pillars: environmental soundness, social justice, and economic viability. Forest certification was initially introduced as a voluntary mechanism by environmental groups to reflect the consequences of deforestation and forest degradation (Rametsteiner and Simula 2003) and was quickly accepted as a mean to promote sustainable forest management (Durst et al. 2006, Siry et al. 2005, Perera et al. 2007). Forest certification is a process by which forest owners voluntarily submit their forest to inspection by an independent certification body to determine whether their management meets clearly defined standards, particularly regarding sustainability (Peck, 2001). Cabarle et al. (1995) argue that the objective of certification is to link the informed consumer with products produced in an environmentally and socially responsible manner. Consumers express their concerns about the ethical behaviour of companies by means of ethical buying and consumer behaviour (De Pelsmacker et al. 2005) and they increasingly demand assurances that the production of goods conforms to minimum standards of social and environmental responsibility (Fischer et al. 2005). Companies who can prove that they are environmentally responsible by being certified will benefit by differentiating their products and increase their market share (Bigsby and Ozanne 2002).

Since their beginning the forest certification schemes evolved, improved and continually implemented interrelated concepts and needs of society, and increasingly became an instrument of governmental procurement policies, obligatory requirements for awarding ecolabels, corporate policies of private companies, requirements for green building initiatives and the accepted tool for proving the legality of timber origin. Rickenbach and Overdevest (2006) state that the dominant model for understanding the effectiveness of certification views forest certification as a market-based incentive for forestry enterprises as supply chain firms adopt certified forest products because they expect direct market benefits. In addition to economic factors, perceived pressure from shareholders, firm size, financial health, past environmental performance, and regulatory threats have been linked to firms' decisions to meet environmental standards voluntarily. Other views understand certification as a signal to external stakeholders that enterprises are meeting high forestry standards or as a policy for the improving of forestry practices and production.

By the end of 2015 the Forest Stewardship Council (FSC) reported over 186 mil. ha and the Programme for the Endorsement of Forest Certification (PEFC) some 272 mil. ha of certified forests.

According to UNECE (2015) the global certified area of 458.4 mil. ha includes an estimated over 7.5 million hectares certified under both schemes with more than 80% double certification in Europe and North America. In the same period FSC registered 29,801 and PEFC 10,744 companies benefiting from the chain of custody certificates. Even if the growth of certified forest area is slowing, there are possibilities for increases mainly in the Southern Hemisphere and for diversification and new approaches to certification.

There have been many studies elaborated regarding chain of custody certification and perception of this issue by the companies (Vlosky and Ozane 1998, Vlosky et al. 2003, Vlosky et al. 2009, Tolunay and Türkoğlu 2014, Vidal et al. 2005, Hrabovsky and Armstrong 2005, Hayward and Vertinsky 1999). For some certified companies the implementation of forest certification provide the satisfaction of supporting the sustainability of natural forest resources and society as a whole (WWF 2000). It may also serve to improve their corporate images and access to markets (Hansen and Punches 1999, Hubbard and Bowe 2004). Trishkin et al. (2014) explored the attitudes and motivation associated with forest certification among forest industry companies in north-western Russia. Market demand was identified as a main driving force influencing development of forest certification; wood legality, company's image and competitiveness of wood products were recognized as the most important benefits associated with forest certification. Despite the comprehensive research carried out worldwide, there are still limited information on the development and status of chain of custody certification in the region of Central and South Europe. There have been several studies elaborated focusing on the establishment and development of forest certification (Dudík and Riedl 2015, Paluš, 2000, 2001, Paluš et al. 2014, Šupín, 2006). but only few concentrating on the attitudes towards forest and chain of custody certification (Paluš and Kaputa 2009, Halalisan et al. 2013).

Therefore, the main objective of this paper is to analyze the current state of chain of custody certification from the perspective of certified companies in the countries of Central and South Europe in terms of understanding of concept and role of forest and chain of custody certification and motives and expectations of companies following from implementation of chain of custody certification.

2. METHODOLOGY

For the purposes of this study the following former transition countries were included: Poland, Slovakia, Czech Republic, Slovenia, Croatian and Serbia. Except of the latter all countries were EU members. The study was carried out using a questionnaire survey. Companies selected for the survey were identified from the international registers of chain of custody holders of the PEFC (2015) and FSC (2015) certification schemes. Database of companies holding a valid COC certificate with available email addresses was constructed and cleared for double certification users; thus giving the total number of 1916 companies to be contacted in the survey. Survey development and implementation was based on the modified methods recommended by Dillman (1987) including pre-notification email, first and second mailing in order to maximise response rates. Data were collected in October and November 2015. The original English versions of mailings and the questionnaire were translated into the respective languages and sent out through national survey coordinators. Totally 881 (45.98%) of responses was received, out of which 744 were suitable for analysis, thus giving the adjusted return rate of 38.83%.

The questionnaire consisted of a cover letter explaining the content and of a number of sections. The first section contained questions regarding the business profile of companies in terms of the geographical localisation, company size, sector represented and the certification scheme used. The second section of the questionnaire contained questions aimed at the examination of companies' level of understanding the forest certification concept both at the sustainable forest management and chain of custody levels as well as to determine the level of agreement with the basic certification statements. The researchers provided definitions of forest certification concepts to assure the consistent frame of reference for the respondent. In the third section the participants were asked to provide internal

information on their involvement in the certification process, namely the motives and benefits they expected from entering certified products market.

A five-point Likert scale was used to measure the level of understanding the certification concepts and level of agreement with principal certification statements and to evaluate the reasons why companies decided to participate in certified prodcuts market. The reliability of factors was tested by using the Cronbach's alpha coefficient. A reliability coefficient of 0.7 and above was considered and acceptable for consistency level (Nunnaly 1978).

Collected data were checked for complexity and analysed by the SPPS statistical package. Frequency analysis was used to present the collected data and the Pearson's Chi-square test for independence was used to measure differences in distribution of categorical variables.

3. RESULTS AND DISCUSSION

As for the geographical structure of the number of contacted companies, some 48.3% were located in Poland, 17.6% in the Czech Republic, 10.5% in Slovenia, 11.2% in Croatia, 7.7% in Slovakia and 4.7% in Serbia. Out of 744 respondents 57% were from Poland, 11% from Czech Republic and Slovenia, 8% from Serbia, 7% from Slovakia and 6 from Croatia.

Companies were mostly representing the primary wood processing sectors (55%), followed by trading companies (25%) and secondary wood processing (20%). The respondents were manufacturers of a variety of products including plywood, sawnwood, chips, pellets, pulp and paper, doors, windows, furniture, wooden constructions etc.

The number of employees was used as an indicator of company size. Small companies (11-50 employees) represent 41% the respondents, followed by equal representation (27% each) of micro (1-10 employees) and medium-size companies (51-250 employees). Only 5% of respondents represented large companies (over 251 employees).

Two certification systems, namely FSC and PEFC, were used by companies involved in the survey. A share of FSC (56%) and PEFC (12%) COC certificate holders reflect the proportion of FSC and PEFC certified companies contacted in the survey (4:1). FSC certified companies were also those holding the SFC Control Wood certificates. The number of these certificates were growing in the countries with the prevailing availability of PEFC certified forests. Additionally, 32% of responding companies were double certified.

All group distributions were tested for differences between the counties. Using the Chi-square test there were significant differences identified between the countries in terms of company size ($\chi^2 = 93.045$, $p = 0.000$), forest product sector ($\chi^2 = 54.192$, $p = 0.000$) and certification scheme implemented ($\chi^2 = 293.199$, $p = 0.000$). The companies' level of understanding the forest certification concept was examined both at the sustainable forest management and the chain of custody levels. There was clearly better understanding of COC concept (score 4.06) than SFM concept of certification (score 3.62) between the companies.

To explore the attitudes of certified companies towards the main objectives and purposes of chain of custody certification, the level of agreement with basic certification statements was examined (Fig. 1) The reliability of examined factors using the Cronbach's alpha coefficient was 0.857. With the highest mean score 4.02 the respondents strongly believe that certification helps to ensure legal origin of wood, followed by the ability of COC certification to trace the supply chain back to the origin source (3.92) and the consequent effect that certification has on the prevention from illegal logging (3.83). These legality issues were closely followed by the sustainability issues, namely promotion of sustainable forest management (3.76) and sustainable utilisation of timber (3.64). The least level of agreement respondents expressed with the statements regarding the improvement of internal efficiency that COC certification can bring to the companies. These include improvement in efficiency of internal material flow, communication and corporate management.

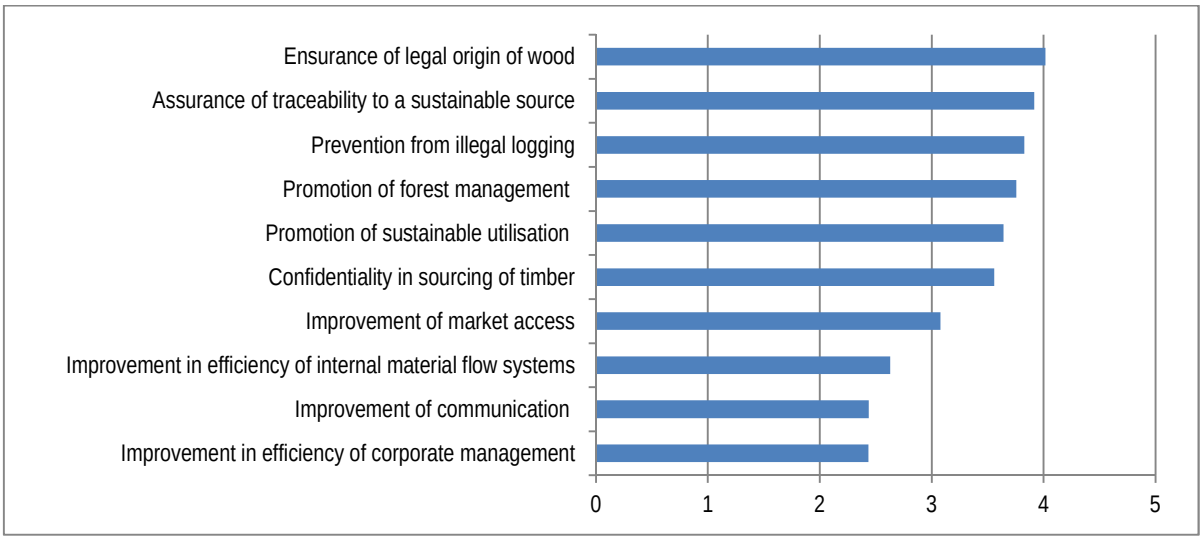


Fig. 1 Level of agreement with basic certification statements

To explore what were the main expectations that motivated companies to enter into the certified products market, companies were provided several options covering a range of the most important benefits the certification may bring. The reliability of examined factors using the Cronbach's alpha coefficient was 0.779. The most important motive was the improvement of external company image (mean score 4.18). Other expectations following from certification were linked to penetrating new markets (3.94) and related increase of sales volume (3.89), expanded market share (3.79) and finally the increase of profit margin (3.74). Other issues such the environmental commitment (3.10) or diversification of products (2.45) were considered as least motivating factors (Fig. 2). It follows that certification is considered by certified companies as a tool that can improve their environmental image, provide access to environmentally sensitive markets and through these activities meet their sales objectives while keeping their original production patterns.

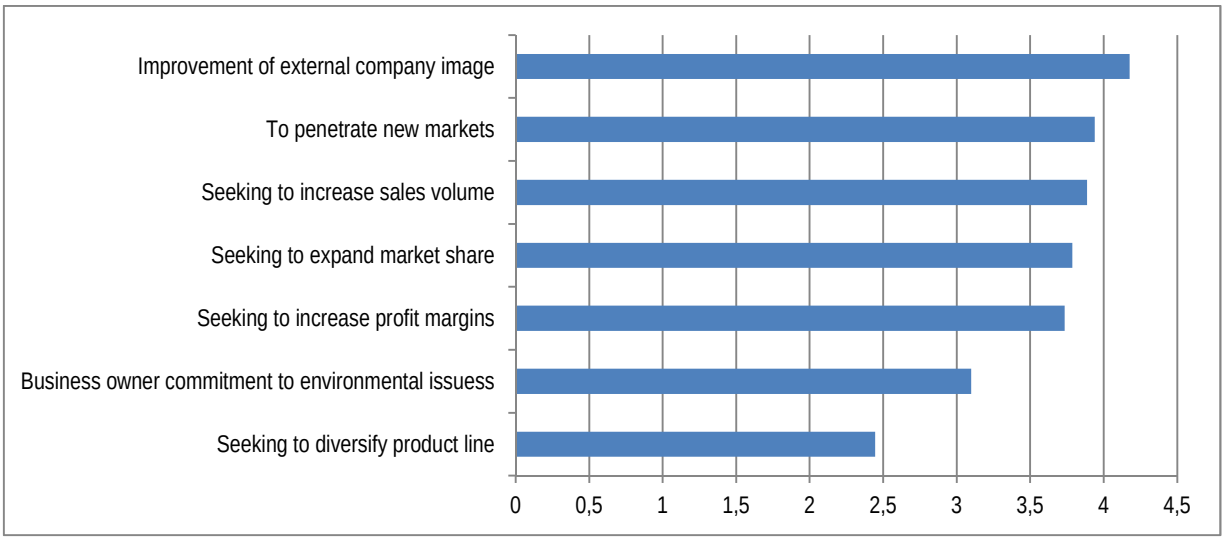


Fig. 2 Main expectations motivating companies to enter into certified products market

In relation to the motives of companies being certified we examined the original incentives for certification. A decision to implement certification requirements as a voluntary tool can be taken by the company itself or the incentive can originate from the existing or potential customers. An initial stimulus to become certified for over 45% of companies originated from the potential customers (Fig. 3) so that certification can be considered an option for companies to increase their sales volume and expand it

terms of market share growth. Using the Chi-square test there were significant differences identified between the countries in terms of original incentives ($\chi^2 = 217.611$, $p = 0.000$).

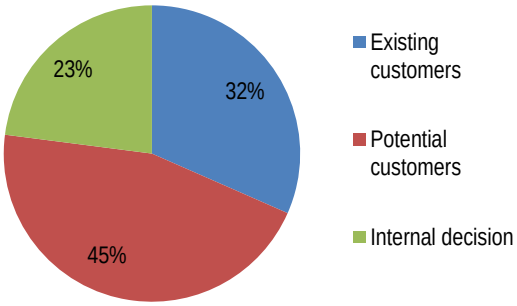


Fig. 3 Original incentives for certification

4. DISCUSSION

Forest certification is mainly connected to the issue of legality, tracing the origin source of supply and a tool that prevents from illegal logging. For the EU countries legality requirements for timber are defied by the European timber regulation (EUTR), which recognises good practice in the forestry sector such as certification or other third party verified schemes that include verification of compliance with applicable legislation to be used in the risk assessment procedure (EC 2016). Criteria for legality are also part of timber procurement policies and cover issues such as legal use rights to the forest, payment of all relevant fees and taxes, compliance with all relevant local and national laws and with the requirements of CITES. In almost all cases they have been adjusted slightly to ensure consistency with the definition used in the EUTR (Brack 2014). Secondly, COC certified companies also see the certification as a tool to promote sustainable forest management and sustainable utilisation of timber, which is in line of the results of WWF (2000). Even if both, FSC and PEFC COC standards, incorporate minimum management requirements, companies do not consider them to be improving efficiency of internal material flow, communication and corporate management.

The main expected benefits following from certification are linked to the improvement of external company image. This factor is related to the environmental communication activities of companies. Vlosky et al. (2009) also documented an increase in perceiving improvement of company image as a benefit following from entering the certification arena. Other expectations following from certification were linked to business performance factors such as penetrating new markets, increase of sales volume, expanded market share and the increase of profit margin. This is in line with findings of Hansen and Punches (1999) or Hubbard and Bowe (2004) who argue that certification may serve to improve corporate image of companies and access to markets. Our results also indicate that companies expect these market benefits with the existing production patterns and there is no need to diversify products portfolio to meet the increasing demand for certified products.

5. CONCLUSION

The study was aimed at examining the status of chain of custody certification in the countries of Central and South Europe, notably in Slovakia, Czech Republic, Poland, Croatia, Slovenia, and Serbia. In all surveyed countries forest certification has been implemented into forest management practices and there is a network of chain of custody certified companies utilising available certified wood resources. In particular, the understanding of concept and role of certification and expectations of

companies following from implementation of chain of custody certification were analysed. The following conclusions can be drawn:

- chain of custody certified companies demonstrated a high level of understanding of the COC concept, nevertheless they reported also considerable awareness with the concept related to the sustainable management of forest resources,
- companies in all surveyed countries link forest certification mainly to the issues of legality, tracing the origin source of supply and prevention from illegal logging, rather than a tool to promote sustainable forest management and sustainable utilisation of timber,
- main expected benefits following from certification are linked to the improvement of external company image followed by business performance factors such as penetrating new markets, increase of sales volume, expanded market share and the increase of profit margin.

Acknowledgements: The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic, and the Slovak Academy of Sciences, Grant No. 1/0473/16, “Dynamics and determinants of wood based products market in the Slovak Republic”.

REFERENCES

1. Bigsby, H.; Ozanne, L.K. (2002): The Purchase Decision: Consumers and Environmentally Certified Wood Products. Forest Prod. J. 52, 100–105. Available online: https://www.researchgate.net/publication/265116728_The_Purchase_Decision_Consumers_and_Environmentally_Certified_Wood_Products (accessed on 17 June 2016).
2. Brack, D. (2014): Promoting Legal and Sustainable Timber: Using Public Procurement Policy. Research Paper. Available online: https://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20140908PromotingLegalSustainableTimberBrackFinal.pdf (accessed on 16 June 2016).
3. Cabarle, B.; Hrubes, R.J.; Elliot, C.; Synnot, T. (1995): Certification and Accreditation: The Need for Credible Claims. J. Forest. 93, 1–12. Available online: http://www.ingentaconnect.com/search/article?option2=author&value2=Cabarle&sortDescending=false&sortField=prism_publicationDate&pageSize=10&index=8 (accessed on 14 June 2016).
4. Dillman, D. (1987): Mail and Telephone Surveys: The Total Design Method; John Wiley & Sons: New York, USA, 1987.
5. Dudík, R.; Riedl. M. (2015): The Possibilities of Using C-O-C Certifications in the Czech Republic. In Wood Processing and Furniture Manufacturing Challenges on the World Market and Wood-based Energy Goes Global, Proceedings of Scientific Papers, Dubrovnik, Croatia, October 7th-9th 2015; Woodema, Zagreb, Croatia, 2015; 229–233. Available online: http://www.woodema.org/proceedings/WoodEMA_2015_Proceedings.pdf (accessed on 17 June 2016).
6. Durst, P.B.; Mckenzie, P.J.; Brown, C.L.; Appanah, S. (2006): Challenges facing certification and eco–labelling of forest products in developing countries. Int. For. Rev. 8, 193–200. DOI: 10.1505/ifor.8.2.193
7. European Commission. (2016): Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market. Available online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010R0995&from=EN (accessed on 16 June 2016).
8. Fischer, C.; Parry, I.; Aguilar, P.J. (2005): Corporate Codes of Conduct: Is Common Environmental Content Feasible? Discussion paper 05–09, Resources for the Future, Available online: http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-05-09.pdf (accessed on 13 June 2016).
9. FSC, 2015. Available online: http://info.fsc.org/certificate.php (accessed on 30 June 2016).

10. Halalisan, A. F.; Marinchescu, M.; Popa, B.; Abrudan, I. V. (2013): Chain of Custody certification in Romania: profile and perceptions of FSC certified companies. Int. For. Rev. 15, 305–314. DOI: http://dx.doi.org/10.1505/146554813807700137
11. Hansen, E.; J. Punches. (1999): Developing Markets for Certified Forest Products: A Case Study of Collins Pine Company. Forest Prod. J. 49, 30–35.
12. Hubbard, S.; Bowe, S. (2004): Putting Value on Certified Forest Products: Views from Wisconsin. Wood and Wood Products. 57–62.
13. Hayward, J.; Vertinsky, I. (1999): High expectations, unexpected benefits—what managers and owners think of certification. J. Forest. 97, 13–17. Available online: http://www.ingentaconnect.com/content/saf/jof/1999/00000097/00000002/art00006?crawler=true (accessed on 15 June 2016).
14. Hrabovsky, E.; E., Armstrong, J.P. (2005): Global demand for certified hardwood products as determined from a survey of hardwood exporters. Forest Prod. J. 55, 28–35.
15. Nunnaly, J. (1987): Psychometric theory; McGraw-Hill: New York, USA, 1978.
16. Rametsteiner, E.; Simula, M. (2003): Forest Certification – an Instrument to Promote Sustainable Forest Management? J. Environ. Manage. 67, 87–98. DOI: 10.1016/S0301
17. Paluš, H. Forest certification and its possible implementation in the SR. (2001): The forest - economy versus ecology: the forum of young scientific on the role of the forest in the third millenium society, zborník z medzinárodnej vedeckej konferencie, Technical University in Zvolen, Zvolen, Slovakia, 2001; 43–46.
18. Paluš, H. Review on certification of non-industrial private forests in Europe. (2000): Marketing 2000 : marketing at break of the millenium, zborník z medzinárodnej vedeckej konferencie, Technical University in Zvolen, Zvolen, Slovakia, 2000; 57–66. . Available online: https://www.tuzvo.sk/files/DF/katedry_df/kmosl/veda_a_vyskum/zborniky/mao_2000.pdf (accessed on 28 June 2016).
19. Paluš, H.; Kaputa, V. (2009): Survey of attitudes towards forest and chain of custody certification in the Slovak Republic. Drewno. 52, 65–81. Available online: http://drewno-wood.pl/pobierz-139 (accessed on 15 June 2016).
20. Paluš, H.; Maťová, H.; Križanová, A.; Parobek, J. (2014): Prieskum znalosti značiek lesných certifikačných schém na výrobkoch z dreva a papiera. Acta Facultatis Xylologiae Zvolen. 56, 129–138. Available online: http://www.tuzvo.sk/files/DF/fakulta_df/AFX/archive/2014/2014-1/14-1-14-palus-matova-krizanova-parobek.pdf (accessed on 15 June 2016).
21. Peck, T. (2001): The International Timber Trade; Woodhead Publishing Ltd.: Cambridge, UK, 2001.
22. PEFC. (2015): Available online: http://www.pefc.org/find-certified/certified-certificates (accessed on 29 June 2016).
23. De Pelsmacker, P.; Driesen, L.; Rayp, G. (2005): Do Consumers Care about Ethics? Willingness to Pay for Fair-Trade Coffee. Journal of Consumer Affairs. 39, 363–385. DOI: 10.1111/j.1745-6606.2005.00019.x
24. Perera, P.; Vlosky, R.P.; Hughes, G.; Dunn, M. (2007): What do Louisiana and Mississippi Nonindustrial Private Forest Landowners Thing about Forest Certification? South. J. Appl. For. 31, 170–175. Available online: http://www.ingentaconnect.com/content/saf/sjaf/2007/00000031/00000004/art00002#expand/collapse (accessed on 25 May 2016).
25. Rickenbach, M.; Overdevest, C. (2006): More than Markets: Assessing Forest Stewardship Council (FSC) Certification as a Policy Tool. Journal of Forestry. 104, 143–147. Available online: http://www.ingentaconnect.com/contentone/saf/jof/2006/00000104/00000003/art00008 (accessed on 15 June 2016).
26. Šupín, M. (2006): Forest and wood products certification influence on strategies for entering and developing international markets. Intercathedra. 22, 166–169. Available online: http://www.up.poznan.pl/intercathedra/pdf/Intercathedra%2022-2006.pdf (accessed on 27 June 2016).
27. Tolunay, A.; Türkoğlu, T. (2014): Perspectives and Attitudes of Forest Products Industry Companies on the Chain of Custody Certification: A Case Study from Turkey. Sustainability. 6, 857–871. DOI: 10.3390/su6020857

28. Trishkin, M.; Lopatin, E.; Karjalainen, T. (2014): Assessment of motivation and attitudes of forest industry companies toward forest certification in northwestern Russia. Scandinavian Journal of Forest Research. 29, 283–293. DOI: 10.1080/02827581.2014.896938
29. United Nations Economic Commission for Europe (UNECE). (2015): Forest Products Annual Market Review 2014-2015; United Nations: Geneva, Switzerland, 2015.
30. Vidal, N.; Kozak, R.; Cohen, D. (2005): Chain of custody certification: an assessment of the North American solid wood sector. Forest Policy Econ. 7, 345–355. DOI: 10.1016/S1389-9341(03)00071-6
31. Vlosky, R.P.; Gazo, R.; Cassens, D. (2003): Certification Involvement by Selected United States Value-Added Solid Wood Products Sectors. Wood Fiber Sci. 35, 560–569. Available online: http://wfs.swst.org/index.php/wfs/article/download/2188/2188 (accessed on 17 June 2016).
32. Vlosky, R.P.; Gazo, R.; Cassens, D.; Perera, P. (2009): Changes in value-added wood product manufacturer perceptions about certification in the United States from 2002 to 2008. Drvna Industrija. 60, 89–94. Available online: http://hrcak.srce.hr/file/59740 (accessed on 17 June 2016).
33. Vlosky, R.P.; Ozanne, L.K. (1998): Environmental Certification of Wood Products: The U.S.Manufacturers' Perspective. Forest Prod. J. 48, 21–26.
34. World Wildlife Fund for Nature (WWF). (2000): The Forest Industry in the 21st Century. Report prepared by the WWF's Forests for Life Campaign [online]. Branksome House, Godalming, Surrey, United Kingdom, 2000. Available online: http://assets.panda.org/downloads/forestind21century.pdf (accessed on 16 June 2016).

Authors address:
Paluš, Hubert*[1]; Parobek, Ján[1]; Vlosky, P. Richard[2]; Motik, Darko[3]; Oblak, Leon[4]; Jošt Matej[4]; Glavonjić, Branko[5] Dudík, Roman[6]; Wanat Leszek[7]
[1] Department of Marketing, Trade and World Forestry
Faculty of Wood Sciences and Technology
Technical University in Zvolen, Zvolen, Slovakia
*Corresponding author: palus@tuzvo.sk
[2] Louisiana Forest Product Development Center
Louisiana State University, Baton Rouge, USA
[3] Department for Production Organisation
Faculty of Forestry
University of Zagreb, Croatia
[4] Department of Wood Science and Technology
Biotechnical Faculty
Univeristy of Ljublana, Slovenia
[5] Department of Technologies, Management and Design of Furniture and Wood Products
Faculty of Forestry
University of Belgrade, Serbia
[6] Department of Forestry and Wood Economics
Faculty of Forestry and Wood Sciences
Czech Agricultural University Prague, Czech Republic
[7] Department of Economics and Wood Industry Management
Faculty of Economics and Social Sciences
University of Life Sciences Poznan, Poland

IMPACT OF ORGANIZATIONAL LEARNING ON THE DEVELOPMENT OF COMPETENCIES: CASE OF SLOVENIAN WOOD-INDUSTRY

Kropivšek, J.; Oblak, L.; Zupančič, A.; Jošt, M.

ABSTRACT

Education and training of employees are important parts of organizational learning and a key to ensuring their competence for the job, which in turn leads to their increased motivation and greater efficiency and quality of work. Wood industry is from a national perspective of strategic importance for the preservation of rural areas and offers wide employment opportunities, but in recent it has become less competitive, mainly because of the low level of knowledge and / or inadequate competencies of employees. In this study we examined the impact of selected trainings as a part of a large project in wood industry on the development of the competencies of four employee profiles. A positive effect of trainings on raising the level of competencies and reduction of deficits were established. This will ensure greater competitiveness of the industry and greater flexibility and efficiency of wood industry companies.
Key words: competency, organisational learning, wood-industry sector

1. INTRODUCTION

Wood industry is from a national perspective in Slovenia of strategic importance for the preservation of rural areas and offers wide employment opportunities, but in recent years it has become less competitive, mainly because of the low level of knowledge and / or inadequate competencies of employees. This is a major obstacle with the Slovenian wood industry, where the level of basic educational achievement among employees is relatively low (Kropivšek et al., 2009). All sorts of business challenges are also forcing companies to maintain and develop skills and knowledge of their employees.

A competency is understood as the "knowledge, ability, dexterity, know-how, experience and other personal characteristics necessary to successfully perform specific tasks" (Svetlik, 2005; Lustri et al., 2007). Marrelli et al. (2005) define competency as a measurable human capability that is required for effective performance. Boyatzis (1982) emphasizes the concept of competency as a personal characteristic, and one that indicates ways of behaving or thinking generalizing across situations and enduring for a reasonably long period of time. Competencies can be divided into technical (job-related skills and knowledge) and behavioral (refer to personal attributes or characteristics) competencies (Yu-Ting, 2010). Competencies are classified into several categories / groups in the literature (Kohont, 2005; Cardy and Selvarajanb, 2006; Thornton and Byham, 1982; Dulewicz, 1989). For the purposes of this research the following groupings are used: (1) generic competencies, which are transferable and not tied to a specific job or task; (2) professional competencies, which are linked to formal education; and (3) job-specific competencies, which are related to business, organizational and technological requirements or restrictions on individual jobs.

Competencies need to be translated into criteria for assessing and developing employees (Cardy and Selvarajanb, 2006). In practice it means continuous, lifelong learning (formal and informal) of all employees (Možina et al., 2002). Education and training of employees are important parts of organizational learning and a key to ensuring their competence for the job, which in turn leads to their increased motivation and greater efficiency and quality of work. Organizational learning is a two-way process of knowledge transfer among individuals, groups and the organization (Örtenblad, 2001; Easterby-Smith et al., 1999; Schiuma and Moustaghfir, 2013). Šebestová and Rylková (2011) define organizational learning as the organizational processes aimed at adding value to the knowledge acquired and communicated throughout the firm. As such, organizational learning processes encompass

the acceptance and assimilation of knowledge. Organizational learning is also described as a key strategic capability that can help explain why successful firms surpass their competitors, and thus learning is seen as an important tool that enables organizations to continuously adapt to rapidly changing market requirements, thus achieving a true dynamic capability (Santos-Vijande, López-Sáncheza and Trespalacios, 2012). The primary aim of organizational learning is the continuous development of new knowledge and its efficient and effective management (Schiuma and Moustaghfir, 2013). Organizational learning mechanisms have a great impact on competencies, as these convert a firm's integrated learning capabilities into core and distinctive competencies through the learning process and adoption efforts of employees (Adams and Lamont, 2003; Bhatt, 2000).

In this study we examined the impact of selected trainings as a part of a large project in wood industry on the development of the competencies of different employee profiles. A positive effect of trainings on raising the level of competencies and reduction of deficits was expected. This would ensure greater competitiveness of wood industry companies.

The specific objectives of this research were as follows: (1) to assess the level of selected competencies for four profiles of employees (employees, which are strongly related to the production) in the Slovenian wood industry, and (2) to determine the effects of systematic training on reducing deficits in these competencies.

2. METHOD

This research was performed as a part within the framework of a large project, where, in the first step, a competency model for six main profiles and several sub-profiles of employees in Slovenian wood industry companies was developed (Kropivšek et al., 2013). In the next step the HR managers in the companies evaluated the level of development of individual competency for each evaluated employee with grades from 1 to 4:

- Grade 1 - Competency not reached (to perform tasks in the workplace correctly this employee requires constant assistance or guidance and supervision of an authority),
- Grade 2 - Competency partially reached (the employee performs work tasks independently, but often needs assistance or guidance and supervision of an authority),
- Grade 3 – Competency mainly reached (the employee performs the work tasks mostly independently and at good quality),
- Grade 4 - Competency reached in full-range (the employee performs work tasks independently, at good quality and meeting expectations).

After the evaluation of the first step a detailed training plan (based on the deficits of competencies), which should reduce or eliminate those weaknesses, was prepared. Trainings were performed during 2013-2015. The last step of this study involves the second evaluation of the level of development of individual competency (from 1 to 4) for each employee who took part in any training. So we got the grades before and after the training.

We calculated relative share of achieving individual grades:

$$\%\ \text{of grade X} = \frac{\text{number of grades X}}{\text{total of all grades}} \cdot 100 \quad (1)$$

- % of grade X is the relative share of individual grades (from 1 to 4) of all grades for competency
- number of grades X is the number of individual grades (from 1 to 4) for the evaluated competency
- total of all grades is the total number of grades for the evaluated competency:
  % of grade 1 + % of grade 2 + % of grade 3 + % of grade 4 = 100%

In this paper, analysis for four profiles of employees (employees, which are strongly connected to the production) are presented:

- Profile 1 – Production workers on simple and less demanding jobs in the woodworking industry
- Profile 2 - Joiners and operators of complex woodworking machinery and technological lines
- Profile 3 - Leaders of organizational units and groups in woodworking production
- Profile 4 - Technologists, designers and constructors of wood products and furniture

3. RESULTS AND DISCUSION

We have analysed only the competencies linked to this profiles (competencies related to foreign languages and health protection and safety at work were excluded). We also excluded the competencies, where less than 10 employees were graded (participated). This ultimately means that the analysis involved 396 employees and 42 different competences (a list of rated competencies is in Annex 1). In the analyses of the level of achievement of competencies we grouped ratings 1 and 2, because both represent a deficit or strong non-achievement of expected level of competencies.

At profile 1 (Production workers on simple and less demanding jobs in the woodworking industry) in total 8 competencies have been analysed (Figure 1). Before the trainings the share of grades 1 and 2 in general was little over 50%, and was lowered to 24% thereafter. Before the trainings the share of grades 1 and 2 at the competency “quality control and production (self-control, interphase control)” (23) was equal to 100%, at two others higher than 50%, while at the other competencies it was less than 40%. After trainings the share of grades 1 and 2 in all the competences declined by almost the half the previous value (45%). At the competences with the highest deficit before trainings the relative improvement in the competencies grades after trainings was the highest (over 60%): “preparation of the workplace” (11), “the performance of less demanding work in production” (13) and “quality control in production (self-control, interphase control)” (23). On the other hand, the relative improvement at the competences with lower deficit was small: the smallest (about 10%) at competencies of “decision making and conflict resolution” (2) and “communication” (7).

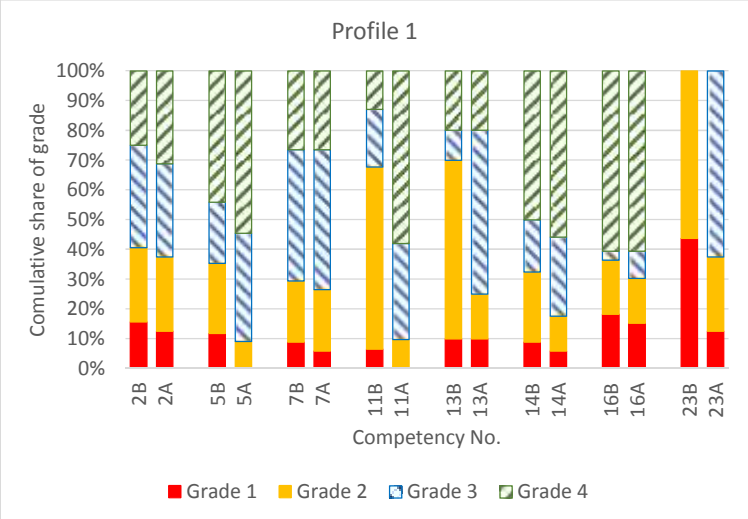


Figure 1. Share of grades 1 to 4 for individual competency before (B) and after (A) for Profile 1 (n=34)

At profile 2 (Joiners and operators of complex woodworking machinery and technological lines) 19 competencies were analysed (Figure 2). This profile represents the largest group of employees in enterprises. At 14 competencies the level of achievement of grades 1 and 2 was less than 20% (at the

competence "management of production department" (29) this share was even 0%), which shows a fairly high level of competitiveness. On the other hand, at three competencies the share of grades 1 and 2 was higher than 60%. After the trainings at 17 competencies the share of grades 1 and 2 was lower than 20%. Rated employees got the lowest grades (a share of grades 1 and 2 was 100%) at competence of "programming and management of CNC technology" (27), which quite improves by trainings, but the share of grades 1 and 2 was still 50% at the end. The average relative reduction of grades with 1 and 2 was 37%. Again, it was the highest among those with the highest deficit.

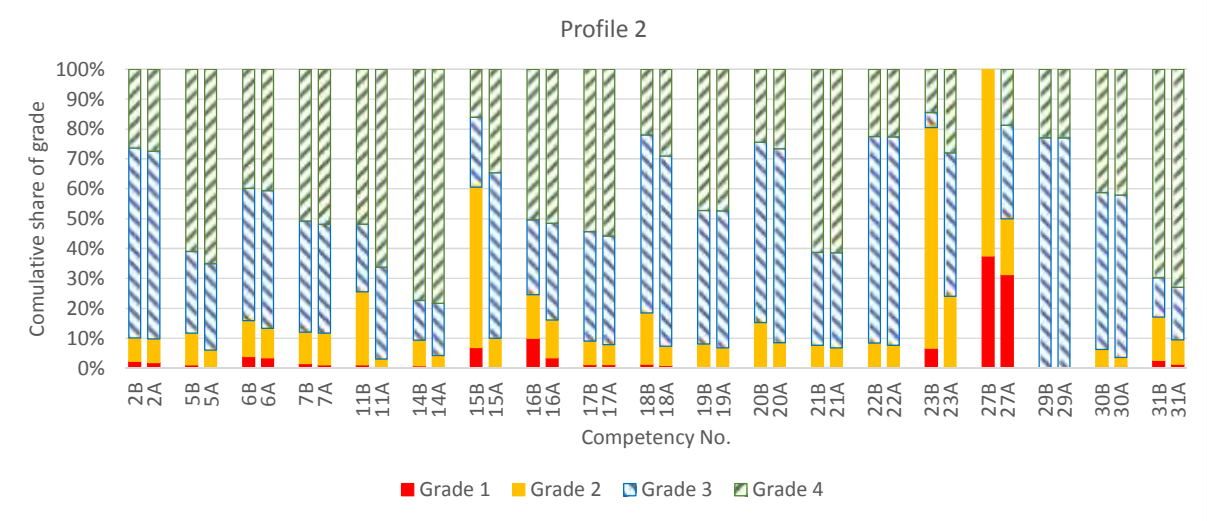


Figure 2. Share of grades 1 to 4 for individual competency before (B) and after (A) for Profile 2 (n=266)

In profile 3 (Leaders of organizational units and groups in woodworking production) we analysed the situation at 12 competencies (Figure 3). For half of these competencies the share of grades 1 and 2 was higher than 50% and the average share of grades 1 and 2 for all competencies was higher than 50% as well. The share of grades 1 within the competencies with the deficit (grades 1 + 2) was the lowest among all profiles (average share of grades 1 in total sum of grades 1 + 2 was less than 7%), which means that most of competencies were at least partly developed. After the trainings the level of achievement of grades 1 and 2 together decreased at all competencies (average relative reduction of grades 1 and 2 was 65%, which was the largest decrease of all profiles). For half of evaluated competencies the level of grades 1 and 2 was at the end less than 20%.

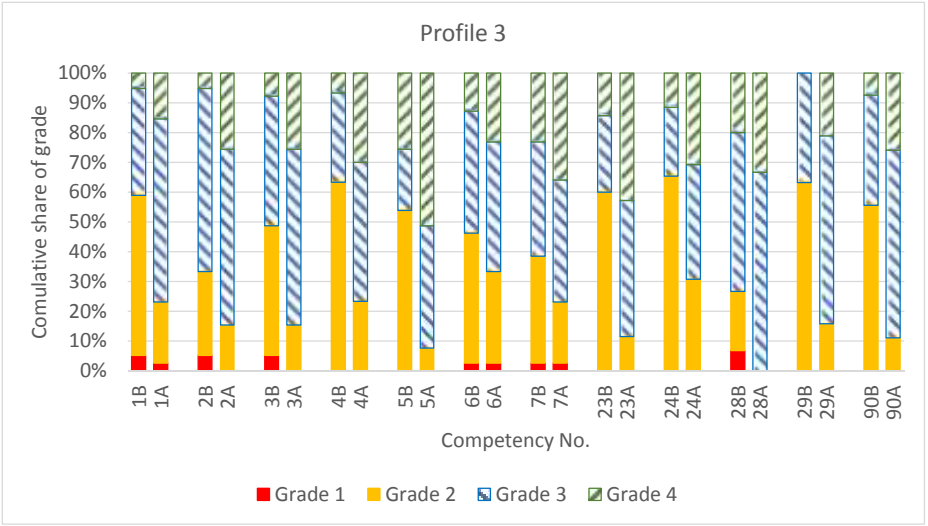


Figure 3. Share of grades 1 to 4 for individual competency before (B) and after (A) for Profile 3 (n=39)

In profile 4 (Technologists, designers and constructors of wood products and furniture) we analysed the level of achievement of the 25 competencies. Before the trainings, the development of competencies rated with the share of grades 1 and 2 was lower than 20% at the eight competencies, higher than 50% at six of them and even 88% at the competence "use of specialized computer tools" (42). After the trainings the level of achievement of competencies improved (share of grades 1 and 2 decreased). Thus, the share of grades 1 and 2 at twelve competencies was less than 20%. In the case of three competencies the share of grades 1 and 2 stayed over or near 50% also after the trainings ("use of specialized computer tools" (42), "creating programs for CNC machines" (40) and "assess the energy efficiency of products (e.g. by thermography, making energy balances)" (45)).

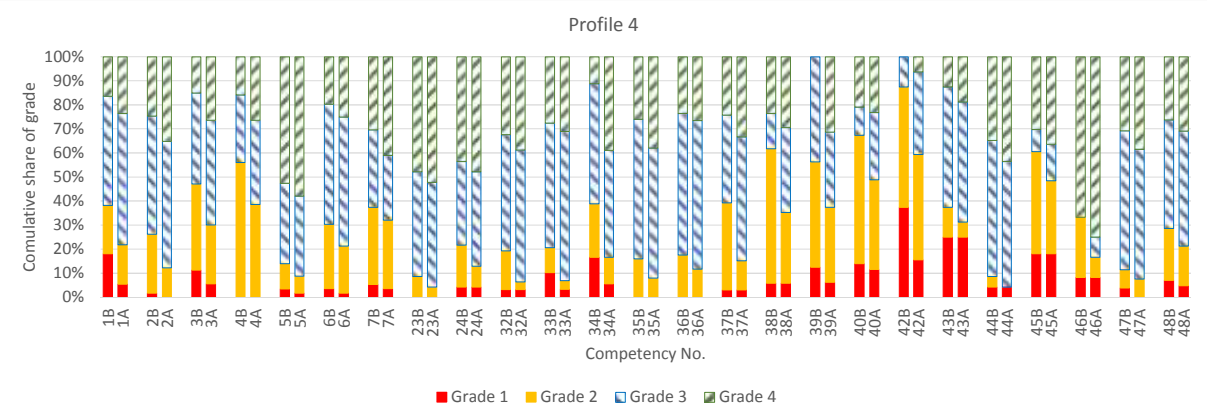


Figure 4. Share of grades 1 to 4 for individual competency before (B) and after (A) for Profile 4 (n=57)

4. CONCLUSION

Competent employees are necessary to ensure competitiveness of a company and industry as a whole. It is true also for wood industry, which has in recent years become less competitive, mainly because of the inadequate competencies of employees. Employees can achieve their competence for the specific job by education and training, which is an important part of organizational learning. Higher level of achievement of competences leads to their increased motivation and greater efficiency and quality of work. In our research we found that in the profiles 1, 2 and 3 the largest deficit was in the field of "quality control", both "general" (5) as well as "self-control" and "interphase control" (23), which decreased dramatically by trainings (for more than 65%). Competence "preparation of the workplace" (11), which is important only for the direct production workers (profiles 1 and 2), had relatively high deficit in profile 1, while in profile 2 this was not so pronounced. Workers in profile 1 had a lower level of education and probably need more stimulus and guidance to arrange the workplace. However, this competency was significantly improved by trainings. Because of the nature of their work employees in profile 3 and 4 have to cooperate well so they should have developed "teamwork" (4) competency. In both profiles the level of achievement of this competency before the trainings was similar (share of grades 1 and 2 was about 60%). In profile 4 it was improved by 30% after trainings, while in the profile 3 it was improved by almost 70% (this profile includes leaders of organizational units and groups in woodworking production, who directly participate and allocate work). In addition, workers also had a deficit on competencies related to the "management of CNC machines" (27, 40) and the "use of specialized computer tools" (42) but there was some competence improved considerably.

It can be concluded that there was a positive effect of the organisational learning and trainings organized within the project on raising the levels of competencies, and thus the deficits in these were reduced. The results showed significant progress in almost all of the 42 analysed competencies. On the whole, the share of deficits (grades 1 and 2) decreased by 52%, which is an excellent result.

Acknowledgements: Part of this research was performed within the framework of project »Kompetenčni center za razvoj kadrov v lesarstvu (KOCles)« which was co-funded by the EU.

REFERENCES (alphabetical order)

1. Adams, G. L., & Lamont, B. T. (2003): Knowledge Management Systems and Developing Sustainable Competitive Advantage. Journal of Knowledge Management, Vol. 7 No. 2, pp. 142-154.
2. Bhatt, G.D. (2000): A Resource-based Perspective of Developing Organizational Capabilities for Business Transformation. Knowledge and Process Management, Vol. 7 No. 2, pp. 119-129.
3. Boyatzis, R. (1982): The Competent Manager, a Model for Effective Performance. New York, NY: John Wiley, 328 pp.
4. Cardy, R. L., & Selvarajan, T. T. (2006): Competencies: Alternative Frameworks for Competitive Advantage. Business Horizons. Vol. 49, Issue 3, May–June 2006, p. 235–245.
5. Dulewicz, V. (1989): Assessment Centers as the Route to Competence. Personnel Management, 21 (11), p. 56–59.
6. Easterby-Smith, M., Burgoyne, J., & Araujo, L. (1999): Organizational Learning and the Learning Organization. London: Sage.
7. Kohont, A. (2005): Razvrščanje kompetenc. In: Pezdirc, M. S. (ed.), Kompetence v kadrovski praksi. Ljubljana: GV Izobraževanje, 165 pp.
8. Kropivšek, J., Oblak, L., Grošelj, P., & Zupančič, A. (2009): Qualification Structure in Slovenian Wood Industry Companies. In Bičanić, K. (ed.) Competitiveness of Wood Processing and Furniture Manufacturing – proceedings. Zagreb: WoodEMA, i.a., p. 149-154.
9. Kropivšek, J., Oblak, L., Jošt, M., Zupančič, A., Leban, I., Štarkl, D., & Mokorel, M. (2013): Model kompetenc za lesarstvo. Ljubljana: Oddelek za lesarstvo, Center RS za poklicno izobraževanje, Kompetenčni center za razvoj kadrov v lesarstvu, 91 pp.
10. Lustri, D., Miura, I., & Takahashi, S. (2007): Knowledge Management Model: Practical Application for Competency Development. The Learning Organization, Vol. 14, No. 2, pp. 186-202. DOI: http://dx.doi.org/10.1108/09696470710727023.
11. Marrelli, A. F., Tondora, J., & Hoge, M. A. (2005): Strategies for Developing Competency Models. Administration and Policy in Mental Health, Vol. 32, No. 5/6, p. 533-561.
12. Možina, S., Rozman, R., Glas, M., Tavčar, M., Pučko, D., Kralj, J., Ivanko, Š., Lipičnik, B., Gričar, J., Tekavčič, M., Dimovski, V., & Kovač, B. (2002): Management: nova znanja za uspeh. Radovljica: Didakta.
13. Örtenblad, A. (2001): On Differences Between Organizational Learning and Learning Organization. The Learning Organization, Vol. 8 Iss 3 pp. 125 – 133. DOI: http://dx.doi.org/10.1108/09696470110391211.
14. Santos-Vijande, M. L., López-Sánchez, J. A., & Trespalacios, J. A. (2012): How Organizational Learning Affects a Firm's Flexibility, Competitive Strategy and Performance. Journal of Business Research. Vol. 65, Issue 8, pp. 1079–1089. DOI: http://dx.doi.org/10.1016/j.jbusres.2011.09.002.
15. Schiuma, G. & Moustaghfir, K. (2013): Knowledge, Learning, and Innovation: Research and Perspectives. Journal of Knowledge Management, Vol. 17 Iss 4 pp. 495 – 510. DOI: http://dx.doi.org/10.1108/JKM-04-2013-0141.
16. Šebestová, J., & Rylková, Ž. (2011): Competencies and Innovation Within Learning Organization. Economics and management, 16. pp. 954 – 960.
17. Svetlik, I. (2005): O kompetencah. In: Pezdirc, M. S. (ed.), Kompetence v kadrovski praksi. Ljubljana: GV Izobraževanje, 165 pp.
18. Yu-Ting, L. (2010): Exploring High-Performers' Required Competencies. Expert Systems with Applications, 37 (2010), 434–439.

Authors address:
Kropivšek, Jože*[1]; Oblak, Leon[1]; Zupančič, Anton[1]; Jošt, Matej[1]
[1] Department of Wood Science and Technology, Biotechnical Faculty, University of Ljubljana, Slovenia
*Corresponding author: joze.kropivsek@bf.uni-lj.si

Appendix 1: A list of selected competencies for profiles 1-4 from the competency model for the wood-industry

Original No.	Competency
1	planning
2	decision making and conflict resolution
3	management and organization
4	teamwork
5	quality control
6	use of information and communication technologies and services
7	communication
11	preparation of the workplace
13	performance of less demanding work in production
14	basic maintenance of work equipment
15	use of production documentation
16	implementation of internal transport (e.g. pallet trucks, forklifts, cranes, etc.).
17	operating machinery in primary wood processing (e.g. machines or lines for cutting logs)
18	demanding machine processing of elements, assemblies, materials and products
19	complex composition and installation
20	management of production lines
21	product installation
22	maintenance, renovation and restoration of wooden products
23	quality control in production (self-control, interphase control)
24	quality control at the receipt / distribution stages (input / output control)
27	programming and management of CNC technology
28	implementation and management of the production process
29	management of production department
30	models and sample production
31	use of special processing techniques
32	technology-engineering production planning
33	operational production planning
34	technology-engineering products planning
35	planning efficient use of wood and other materials
36	preparation of production documentation
37	technology optimization and complex technological problem solving
38	development and design of wooden products and structures with a technical-technological point of view
39	development and design of wooden products and structures (design and structural aspects)
40	creating programs for CNC machines
42	use of specialized computer tools
43	monitoring legislation and / or standardization (related to their field of work)
44	measurements in the field
45	assess the energy efficiency of products (e.g. by thermography, making energy balances)
46	cooperation in restoring cultural and technical heritage made of wood
47	creation of surface treatment processes
48	testing materials and products
90	organization, management and supervision of the work in their field


FOREST
PRODUCTS
SOCIETY

THE CONCEPT OF CASCADED USE OF WOOD IN SLOVAKIA

Parobek, J.; Paluš, H.

ABSTRACT

Wood is a multipurpose and renewable material that can be used sustainably for various purposes in different sectors. At the present time new approaches such as cascading use of woody biomass is gaining increasing attention to ensure the sustainable utilisation of renewable resources. The concept of cascading can help to optimise the use of wood in the whole chain of its processing and utilisation. The aim of the paper is to analyse and describe cascading use of wood in the primary wood processing industry in Slovakia and to outline ways to increase efficiency of wood utilisation in the country. Using the production, trade and consumption data for the sector in the year 2013 cascade coefficients are calculated.
Key words: sustainable wood production, cascade coefficient, wood, wood products

1. INTRODUCTION

A significant increase in logging can cause over extrapolation of the forest resources. Such situation may raise serious concerns about the sustainable way of wood utilisation. Therefore, wood consumption must be assumed and coordinated with the demand for traditional as well as innovative wood products. A lot of studies (Raunikar et al. 2010, Bongiorno et al. 2011, etc.) assume increasing demand for wood and non-wood products in the EU mainly due to an expected increase of energy consumption of the renewable resources. As a result of growing demand in the future the increase in prices of energy wood may have a negative impact on the prices of industrial wood. A price increase may consequently decrease the competitiveness of the wood processing industry (WPI). These companies must continually strive to improve or at least maintain their market share (Oblak, Glavonjić 2014). Competitiveness of each sector depends on the process of restructuralisation and modernization of production facilities as well as the process of specialization of production (Šupín 2013).

On the other hand, it is necessary to take into account the fact that the WPI also produces significant amounts of wood residues (30-50% of the volume of processed wood), which can be used for energy purposes. From this perspective, it is important to prefer outputs with higher added value, creating jobs and contributing to a better carbon balance (resource efficiency). A different way of potential wood and wood residues utilization in the value chain is described in the concept of cascading use of wood products. Cascading use of biomass can be defined as multiple use of the wood from trees by using residues, recycling (utilization in production) resources or recovered (collected after consumption) resources (Sokka et al. 2015). The more often by products and recycling products are used the higher cascade factor gets. The cascade principle means to use wood from forest in an effort to increase added value of wood. It also means that wood should be primary used in the construction, furniture or other products with a long life cycle and energy should primarily be generated from waste or recycled products. In this sense we consider energy uses of wood as the least preferred way of utilization. The concept of cascading use of biomass can be defined as cascading in function. It is actually co-production, which can be achieved by using bio-refinery. Co-production is the production of different functional streams (e.g. protein, oil and energy) from one biomass stream, maximizing total functional use. Of course, after cascading in function, cascading in value or time follows. The cascading in time meaning that the life span of biomass use is increased (e.g. paper recycling). Another approach can also be defined as ‘cascading in value’ meaning that the maximum value of the whole life cycle of biomass is gained through optimizing the use of biomass for multiple services (Odegard et al. 2012).

Slovakia belongs among the most forested countries in Europe with forest cover 42%. According to the national statistic annual wood production in 2013 was over 8 million m3. The problem is the proportion of incidental felling, which reached 3.2 million m3 (38.57% of total) which has influence on wood supply. The WPI has processing capacities sufficient to process all harvested volume of softwood in Slovakia. Nevertheless, the export of roundwood is three times higher than import. Tab. 1 describes the variability of wood assortments between exports and imports. The share of top quality assortments is almost 54% (mainly softwood logs with a share of 46.3%). On the other side of this balance imports are dominated by lover quality assortments with a share of 66.4% of pulpwood (almost all non-coniferous). At the present time the WPI consume about 6 million m3 of wood (except energy wood). The increased demand for coniferous logs and broadleaves pulpwood is visible in Slovakia. The most significant consumers are sawmills with a volume of 2.5 million m3 of processed wood. However, there is a low level of production of wood products with higher added value, in particular veneers and plywood and lacking production of soft and medium density wood based panels. The volume of best quality logs processed is also low. The potential of a special quality logs that can be produced is about 40 thousand m3 of coniferous wood and 260 thousand m3 of non-coniferous wood annually. In many cases, domestic wood processing companies are mostly subcontractors of foreign enterprises. The exception is pulp and paper industry with the capacity of 2.9 million m3 processed wood. It is the second most important sector consuming wood and one of the most powerful sectors in the Slovak economy. A total of 11 big companies cover 100% of paper production. The last but not least is the furniture industry as an important consumer of wood. In 2013, this sector processed 876 thousand m3 of roundwood.

Table 1. Foreign trade of roundwood in Slovakia 2013

Wood assortments	Export		import	
	m^3	%	m^3	%
Coniferous logs	1 444 000	46.3	78 000	8.5
Coniferous pulpwood	525 000	16.8	64 000	6.9
Non-coniferous logs	238 000	7.6	105 000	11.4
Non-coniferous pulpwood	455 000	14.6	549 000	59.5
Energy wood	460 000	14.7	126 000	13.7
Total	3 122 000	100.0	922 000	100.0

Source: ŠUSR (2015)

2. METHODOLOGY

Analysis of cascading use of wood is based on the methodology of the analysis of the wood balance, which aims to establish balance between resources and the uses of wood. The quality of the final wood resource balance depends directly on the quality and availability of data on wood production and use in individual sectors. Empirical research and expert estimations based on the available production data are commonly used to obtain the missing data. Under current conditions, wood resource balance data can be compiled as a mix of officially published and empirically collected data. Official statistics are available for highly concentrated sectors such as the pulp and paper industry. However, certain sectors of the wood processing industry, such as the sawmill industry, are poorly concentrated; thus, access to data is complicated (Parobek et al. 2014, Loučanová and Kalamárová 2014). The resource side is represented by the production and import of wood, recycled material and waste from the WPI. The paper focuses on the primary wood processing as a major producer of generates wood waste. Flows of waste are used in different levels of wood processing (industry and energy sector). A cascade analysis describes flows of wood focused on the identification and quantification of the waste and roundwood use.

The same approach has been applied in Slovakia. The flows of wood as raw material and flows of wood residues as a waste from the process of wood products production were identified separately. The flows of wood residues were complemented by recycled wood and paper (post-consumer material). Wood as an elementary input comes from domestic sources (forest) and from the import. The production of roundwood was analysed in the structure corresponding to the main groups of assortments in terms of their use and quality (logs, pulpwood and energy wood). The concept of cascading is focused on the domestic utilization and therefore it was necessary to estimate the domestic consumption (apparent consumption).

Based on wood balance of the available resources and the description of wood flows it was possible to describe and quantify cascading use of wood. Cascading use is defined as multiple use of wood from the forest with wood residues from the forest industry. The more times the wood residues and by-products are produced during industrial processing of wood the higher factor cascade gain. The sectors of the WPI in Slovakia are interconnected. For example, the waste from sawmills is used for industrial purpose (use in the production of wood base panels and pulp), as well as a source of energy (the production of end products such as pellets or briquettes). It can be also used outside the WPI for the production of energy in other sectors, heating plants and households. In case that the inputs to the process is only roundwood without additional other sources, the cascade factor takes the value 1.00 (Mantau, et al. 2010).

3. RESULTS

In Slovakia main wood assortments are coniferous and non-coniferous logs and non-coniferous pulpwood. These assortments represent more than three quarters of total wood production. The main part of coniferous logs is consumed by the sawmill industry. In 2013, the total volume of produced coniferous and non-coniferous sawlogs was 3.9 million m3, but taking into account the high exports domestic consumption was over 2.7 million m3. In the processing of wood there is a high proportion (approx. 40%) residues such as sawdust, chips, dust, etc. The highest quality logs for veneer (veneer annual production approx. 19 thousand m3 per year) are produced on a small scale. Fig. 1 describes the flow of wood waste and sawnwood in the processing of logs in sawmill operations.

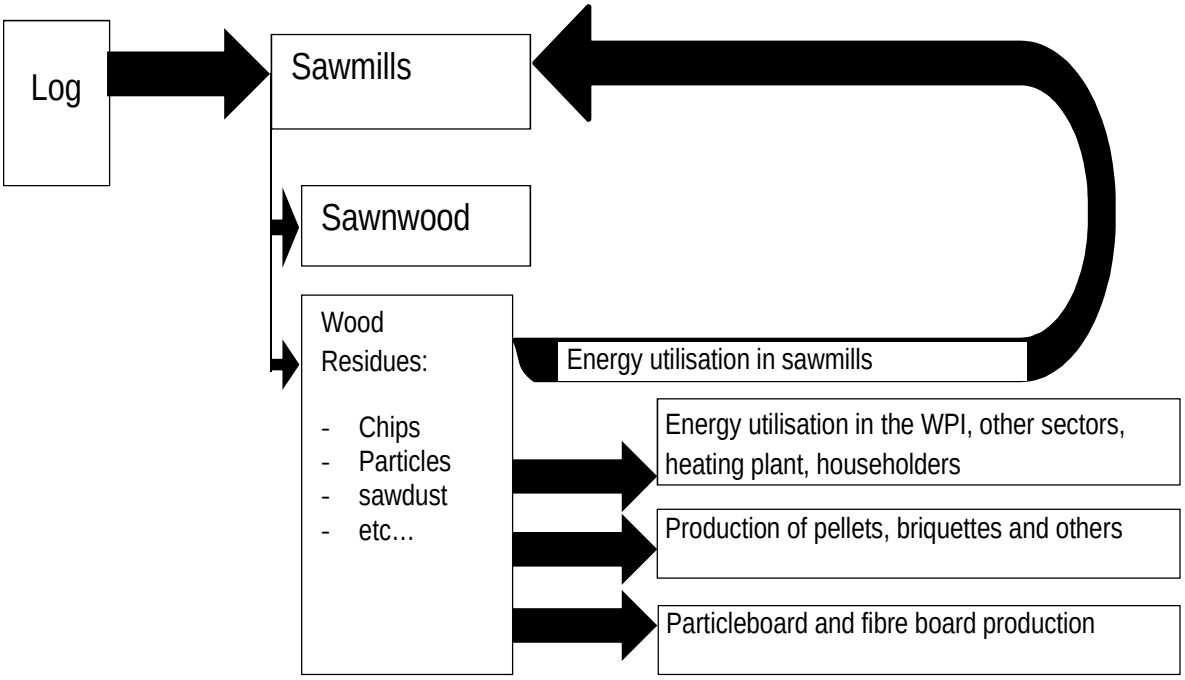


Figure 1. Wood flows in sawmill operations

Pulp and paper industry (woodpulp annual production approx. 700 thousand tons per year) and production of wood based panels (particleboard annual production approx. 0.5 million m3 per year) primarily use wood fibres. Those sectors focus on non-coniferous wood species. Currently the production of pulp and paper is the second most important sector of wood processing in Slovakia with the total output of almost 2.4 million m3 tons per year. Taking into account foreign trade (import) Slovakia consumed more than 2.75 million m3 of pulpwood. Fig. 2 describes the flow of wood waste and pulp and paper products in the processing of non-coniferous pulpwood in Slovakia.

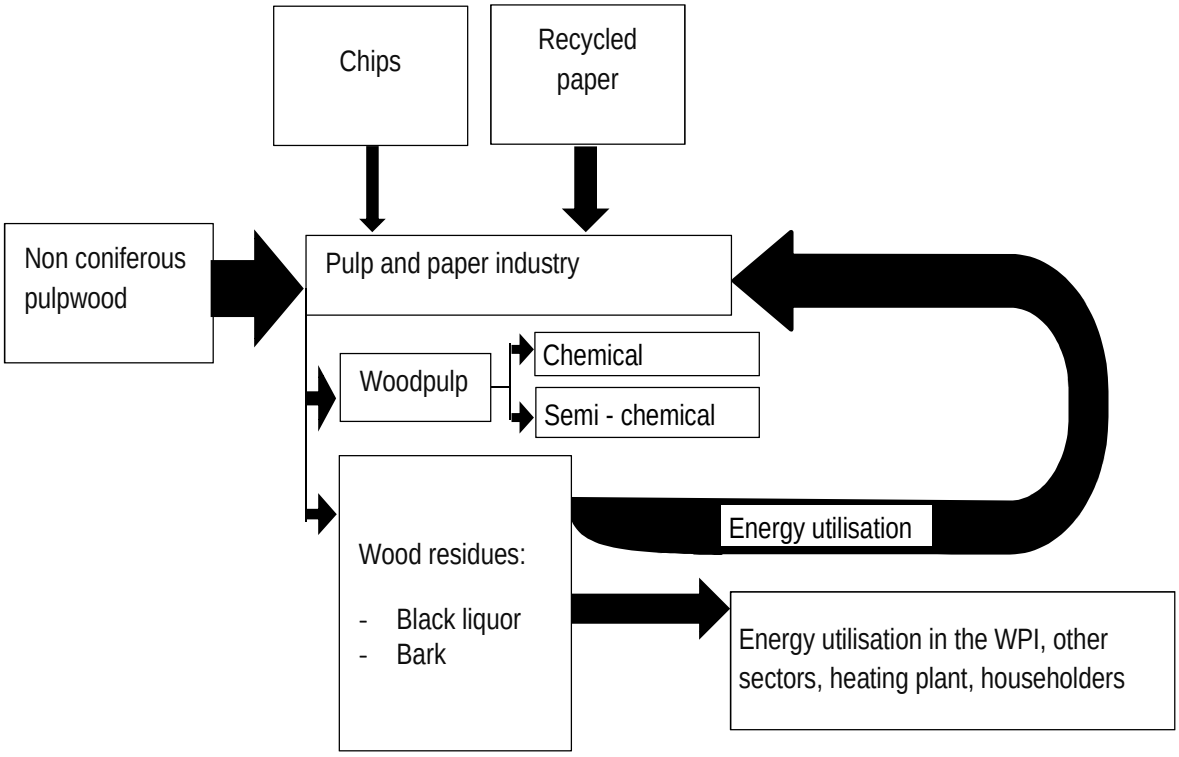


Figure 2. Wood flows in pulp and paper production

The processing of wood generates secondary products and waste, which can be an important source for further processing. The waste streams are represented by different types of waste generated during the logging operations (e.g., logging residues) as well as the waste generated during primary mechanical and chemical processing of wood (sawdust, chips, black liquor, etc.), which can be used either industrially or for the production of energy. In Slovakia energy industry is significant consumer of wood residues from sawmills. An exception is the production of liquor which is processed by the producers themselves mainly for energy generation. Comparing to sawmills wood based panel production sector produces minimal wood residues. The residues are consumed by the producers themselves in the production process. Currently, there are no official statistics in Slovakia on volume and flows of wood residues from sawmills available, however, the empirical research (Parobek et al., 2014) estimated volume of waste in the WPI about 1 million m3, which can be further, processed in industrial or energy industry. Another important source of wood for domestic consumption is wood form non-forest land (especially abounded agricultural land), which current production is estimated at over 580 thousand m3 of wood.

In Tab. 2 cascade coefficients are calculated for the whole WPI sector. The coefficients were separately calculated for the wood processing industry and energy industry, as well as for particular flows of waste. According to total value of felling (more than 8.7 million m3) domestic consumption was

estimated almost 5.9 million m3 based on the balance of wood. Total cascaded coefficient of wood utilization in Slovakia is 1.48. It means, that with a consumption of 5.9 million m3 of wood in Slovakia the WPI returns about 2.8 million m3 in the form of waste and by-products back into the WPI, other industries, energy producers and households.

Table 2. Cascade factors for the wood resource balance as a whole, and for the WPI

Utilizations factors	Volume (m^3)	Cascade factors
Consumption of roundwood in the SR	5 931 159	1.00
Biomass from forest for energy	772 570	1.13
By-products and waste utilize in the industry	780 000	1.13
Recycled material (paper)	1 010	1.00
By-products and waste utilize in the energy	1 927 430	1.26
Utilization of waste	2 707 430	1.42
Wood processing industry	781 010	1.13
Wood for energy	2 700 000	1.42
Total cascaded coefficient of wood utilization	8 639 598	1.48

Based on available data flows of wood waste cascading coefficients in different ways of utilizations were determined. However, there is a more significant difference in the value of coefficient in energy sector compared to industry sectors. In other words, the coefficients indicate the orientation of utilization of waste for energy purposes (cascade ratio represents a value of 1.42). In the WPI there is cascading coefficient only 1.13.

3. CONCLUSION

Wood cascading considers complete wood using cycle and recognizing the differences in wood flows. The concept of cascading can help to optimize the use of wood in the whole chain of its processing and utilization in Slovakia. Results of the analysis can help in many innovations to increase the efficiency of the cascade of wood processing.

The utilisation of wood is continually changing, and the demand for roundwood is changing depending on the technologies and on the demand of final wood products. On one side, wood and wood products production is subject to available resources and has been recently influenced by the high proportion of accidental felling. On the other side, wood production tries to adapt to rapidly changing on the market. The applied concept of cascading can describe the actual consumption of wood in various forms. The outcome of the analysis of wood material flows and cascading concept in Slovakia go out the balance between the resources and the primary uses of wood and wood residues. The analysis describes in detail the relationships between resources (wood and waste), basic production indicators, foreign trade relations, and the use of raw wood material and waste in the domestic conditions.

Acknowledgements: The authors are grateful for the support of the Development Agency, Grant APVV-14-0869 “Research of the utilization of wood as renewable raw material in the context of green economy.”

REFERENCES

1. Buongiorno, A.; Raunikar, R.; Zhu, S. (2011): Consequences of increasing bioenergy demand on wood and forests: An application of the Global Forest Products Model. Journal of Forest Economics, 17 (2): pp. 214-229.
2. FAO (2015): FAOSTAT – Forestry. URL: http://faostat.fao.org.
3. Mantau, U.; Saal, U.; Prins, K.; Steierer, F.; Lindner, M.; Verkerk, H.; Eggers, J.; Leek, N.; Oldenburger, J.; Asikainen, A.; Anttila, P. (2010): EU wood real potential for changes in growth and use of EU forests. Final report. Hamburg. Germany. URL:http://www.egger.com/ downloads/bildarchiv/187000/1_187099_ DV_Real-potential-changes-growth_EN.pdf
4. Loučanová, E.; Kalamárová, M. (2014) Postupy a nástroje na riadenie inovačných projektov. In: Trendy a inovatívne prístupy v podnikových procesoch: 17. medzinárodná vedecká konferencia. - Košice: Technická univerzita v Košiciach. Slovakia. December, 2014. 1-8.
5. Odegard, I.; Croezen, H.; Bergsma, G. (2012): Cascading of biomass, 13 solutions for a sustainable biobased economy, CE Delft. URL: http://www.cedelft.eu/?go=home.downloadPub&id=1277&file=CE_Delft_ 2665_Cascading_of_Biomass_def.pdf
6. Oblak, L.; Glavonjić, B. (2014): A Model for the Evaluation of Radio Advertisements for the sale of Timber Products. Drvna industrija 65 (4): pp. 303-308
7. Parobek, J.; Paluš, H.; Šupín, M.; Kaputa, V. (2014): Ananalysis of wood flows in Slovakia. BioResources 9 (4): pp. 6453-6462
8. Raunikar, R.; Buongiorno, J.; Turner, J. A.; Zhu, S. (2010): Global outlook for wood and forests with the bioenergy demand implied by scenarios of the Intergovernmental Panel on Climate Change. Forest Policy and Economics, 12 (1): 48-56.
9. Sokka, L.; Koponen, K.; Keränen, J. T. (2015): Cascading use of wood in Finland– with comparison to selected EU countries. URL: http://www.vtt.fi/inf/julkaisut/muut/2015/VTT-R-03979-15.pdf
10. ŠUSR. Statistical Office of the SR (2015): Slovstat. URL: http://slovak.statistics.sk
11. Šupín, M. (2011): Analýza vplyvu globalizácie na slovenský drevársky priemysel v prvej dekáde 21. storočia. In: Marketing a obchod 2011 "Vplyv volatility a interdependencie v svetovom hospodárstve na marketing a obchod". Slovakia. May, 2011. 282-286.
12. Šupín, M. (2013): Slovak and EU Market with Wood Pellets. Intercathedra 29 (2): pp. 74-81.

Authors address:
Parobek, Ján*[1]; Paluš, Hubert[1]
[1] Department of Marketing, Trade and World Forestry; Faculty of Wood Sciences and Technology; Technical University in Zvolen, Zvolen, Slovakia
*Corresponding author: parobek@tuzvo.sk

A PUBLIC VIEW ON ETHICAL PARTNERSHIP

Kaputa, V; Šupín, M; Kršáková, A.

ABSTRACT

Corporate social responsibility is a modern business concept, which takes into account not only economic but also social and environmental interests of the company. The Technical Research Center of Finland has created five imaginary stories of possible cooperation between a newspaper publisher and a paper company regarding to the environment. Intention was to identify what kinds of activities of companies are considered as responsible and what marketing tools should company use to present its environmental efforts. The consumers' views on the environmental sustainability were collected utilizing an on-line co-creation platform OWELA. The same survey was also carried out in the Slovakia. The result indicates that the readers would like to be identified in sustainable actions as active partners instead of treating them as a passive audience.
Key words: ethical partnership, environmental responsibility, paper company, newspaper publisher.

1. INTRODUCTION

The pulp and paper industry is one of the largest sectors in the Slovak economy and it represents the most developed wood processing sector in the country characterized by a high degree of geographic concentration (Parobek, 2010; Šupín 2011). There are 11 companies in the sector that account for 100 % of paper production. The main pulp and paper mills are owned by transnational corporations and they have undergone massive reconstructions including complete upgrades in production technology during the past 15 years (Kaputa et al., 2016). The presence of globalisation is evident in the Slovak woodworking industry for more than two decades. Moreover, this sector is strongly shaped by the influence of the financial and economic crisis (Šupín 2011, Paluš and Parobek 2011, 2012). We can assume that corporations can't take the whole responsibility for the global problems and the current crisis. They also can't solve the global problems. The new model of cooperation among corporations and the rest of the society is needed, it means the cooperation among stakeholders such as governments, transnational corporations, NGO's, communities etc. This new model could be based on the strong and valid values (Dvořáček and Maťová, 2013). Environmental issues belong to the spectrum of global problems and are sensitively perceived by final consumers of a wide spectrum of wood products. Their awareness is also linked to the chain: forest-wood-paper. As far as companies realised consumers' environmental perceptions, they consider what kind of behaviour or marketing appeals would be the best to communicate their environmental values. Kaputa (2013) surveyed Slovak wood processing companies and most of them consider Slovak consumer as environmentally non-sensitive. The companies did not assume there is a real demand for environmentally suitable wood products. In spite of that fact, over 70 percent of companies claimed that they have perceived (in different ways) changes in their customers' preferences for environmental worthiness of wood products. Those changes indicate formation of a new market segment.

Wood and wood products demand is derived demand in terms of the way how it is created and it depends on the final wood products demand. At the same time with the wood products demand there is a demand for the competitive products. In relation to wood as material the competitive products (materials) take a position of substitutes. The main feature of the substitutive materials is that they can satisfy the same needs and the buyers (purchaser) and consumers have the possibility to choose among them according to their individual preferences. Preferences are typical for consumer markets. Significant advantages of wood are its ecological characteristics and the ability of being sustainable renewable (Paluš et al., 2012).

The aim of the study is to assess what kind of activities (co-operation between a media house and a paper company) would be perceived by non-expert stakeholders as environmentally responsible and reliable.

Seisto et al. (2014) set up methodology of this paper and carried out study in Finland. The Finnish participants found the ethical partnership between paper producer and media house a desirable concept, although they were a bit sceptic about the included elements of the study. The prerequisites for credible ethical partnership include: "True impact" (the actions for sustainability and social responsibility should have a real impact; no green washing is accepted), "Noble motivation" (both partners should have a clear role in their own strong areas for advancing sustainability; sponsorship is not enough) and "Extensive definition of company responsibility" (credibility is required in all areas of company responsibility). Finnish researchers (ibid) find out that the participants were most satisfied with the concept which required active participation of readers/consumers and increased their knowledge and understanding on a well-defined case concerning sustainability.

2. METHODOLOGY

The study was conducted in VTT Owela platform (Open Web Lab developed by Technical Research Centre of Finland). Owela is used as a virtual living lab to carry out the study. The narratives and part of the Owela platform were translated and fully available in Slovak language. The participants were invited to the on-line workspace to share ideas, discuss and give feedback about the concepts of ethical partnership. Five short narratives describe co-operation (partnership) between a paper company and a media house. The aim was to recognize the most suitable way for 'ethical partnership' what included mainly actions targeting to environmental sustainability, but also actions concerning social responsibility. The main issue was about how a paper producer and a media house may work together towards a common goal of sustainable print products and how the consumers respond to the co-operation. The core messages of the narratives (not full narratives) are presented below (Seisto et al., 2014):

1) Eco-label: Ecological values and especially biodiversity were underlined. The producer of magazine paper has committed to protection of certain species, which is informed with a particular eco-label and short information text.
2) Common event: Newspaper publisher owns a woodlot in a forest owned by a paper company. The companies arrange informative reader excursions to the woodlot together.
3) Symbolic eco-act: Small acts targeted to improve our own environment: a paper company donated plants for a magazine, which planted the trees with the readers in order to diminish CO2-load.
4) Information channel: Acts of company's social responsibility included in a journal article: Main theme in the magazine issue is travelling in Brazil. In a portrait is presented a teacher, who started his studies in a Brazilian school founded by a paper company.
5) Common campaign: Tour for collecting electronic waste: information about the environmental load of electronic devices available in publisher's magazines, also lot of information about the tour.

Majority of the Slovak participants were university students (Master studies). Registered persons were asked to participate on the project and express their opinions / attitudes towards narratives. There were 25 persons registered to the project. 20 of them were actively engaged to the discussion which last 4 weeks and resulted in 96 comments.

3. RESULTS

Demographic characteristics of the Slovak participants' sample describe Table 1. Primary group of Slovak users were young people (under 30 years old, university students).

Table 1. Sample of active participants (n = 20)

Gender	
Women	14
Men	6
Age	
< 30 years old	17
30-40 years old	2
40-50 years old	0
50-60 years old	1
> 60 years old	0

The qualitative study brought an interesting discussion about the message of individual narrative. The most positive feedbacks had the narrative describing common campaign. It is considered as eligible, believable, achievable and needful. Afterwards, symbolic eco-act followed by common event were assessed positively too. The narratives information channel and eco-label exuded negative reactions as they have only information character and do not require active participation. Moreover, these two narratives were considered for unrealizable, mistrustful and unclear.

Table 2 introduces frequency of positive and negative comments as well as frequency of comments expressing both – positive and negative – evaluation of the individual narratives.

Table 2. Comments' evaluation

Narrative	Positive +	Negative -	Both +/-	Number of comments	Order
Eco-label	2	12	6	20	5.
Common event	15	3	1	19	3.
Symbolic eco-act	16	0	3	19	2.
Information channel	4	12	2	18	4.
Common campaign	19	0	1	20	1.
Total				96	

Common campaign as the most positively assessed narrative is considered for very useful, interesting, effective, believable and realistic. The narrative combines ability to inform, presents recycling and has real impact on environment. Many participants would even shift it further and suggested various ways as "to encourage the readers to recycling by competition. For example, when they take a picture of themselves with electronic waste and send the photo (or add and tag it on FB / Instagram) it can be published in the magazine and the most interesting photos will receive a small reward." or not just to collect the electronic waste, but "start to intensively communicate what the environmental load brings this waste and not buy such amount of electronics". Others emphasized the importance of information spreading: "Many people do not come to idea to protect our environment by themselves, if they were not leaded to it. Those who have not this idea will hardly take into account recycling. It is also good to know what kind of readers magazine has since it plays a role if right information achieve right target group. Anyway, I guess that people who read the magazine are at least motivated to act."

Symbolic eco-act concentrates on consumers' activation to co-operate. An idea to involve employees of magazine and readers for small good deeds on voluntary base was very prized.

Participants noted that this idea is "like teambuilding – funny and strengthen relations. Moreover, it is beneficial for environment". Some noted that the magazine as mass medium "should promote such activities to motivate others". There were also critical attitudes:
"I like the idea of symbolic eco-act, but it is hypocritical regarding paper's company – they donate trees planting to cut them down few years later.

Common event has informative character. The participants appreciated its educational character because: "if we know something deeper it could influence our decisions and habits (environment protection, buying recycled paper)". Some participants like the idea, but criticized involvement of paper's company quoting a fact that the woodlot will be cut down finally for a production purposes: "Do they show them (during excursion) areas after clearcutting?" or "The same people should be taken to the same part of the forest a few years later to see what really happen with this forest. It should show how enterprises affect on the forest."

The narrative information channel combine elements of information providing and presentation of sustainable actions of partners' companies. The participants were quite skeptical assessing this story, though identified some positive elements. The narrative was incomprehensible, poorly described and the issue has not been understood for many participants. The most mentioned deficiencies included a lack of clarity, lack of information about the environment and vice versa abundance of information about travelling, which ultimately does not sound ecologically. The participant with indifferent comment: "I like presentation of common Brazilians' life, but it is also indirect presentation of a Finnish company".

Most negative emotions evoked narrative eco-label, which as well as the narrative information channel combine elements of information providing and presentation of sustainable actions of partners' companies. There were only 2 positive (within overall 20) comments: "It is very important that the one who takes also gives back. If the company cares also about animal of the forest and reduce the impact of its activities, so I see it as a good step." Some comments assess the idea as "good but unreal". It refers to an issue how to prove that a woodpecker is really protected. Moreover, long-term observing is needed to see results. Negative comments relate to non-conceptual approach ("protection of only a one kind") and definitely non credibility of the narrative ("How to protect a woodpecker after forest will be harvested?").

4. CONCLUSIONS

It could be concluded that active participation of public is considered for the most suitable way how to present ethical partnership (environmental responsibility) of a publisher and a paper company. The participant emphasized increase of knowledge and better understanding in case of involve them into sustainable actions. Posing readers/consumers to a passive role brings less trustful, rather sceptical assessment of any actions performed by business partners. The example is the narrative about an eco-label perceived as non-credible. Generally, number of commercially used eco-labels and declarations (often not certified) brings vague information for end-users. Consecutively, they tend to ignore them or consider them as a kind of greenwash.

Common campaign is the most positively assessed narrative. The activity is perceived by majority as "very good idea", effective, believable and realistic. Although the role of a paper company in the narrative is not clear, this kind actions should be utilise as trustful demonstration of the corporate responsibility and ethical partnership between a publisher and a paper company.

Analysing qualitative results could be concluded that volume of paper production and consumption is sensitively perceived in society due to presumed environmental consequences. It is connected to an opinion of individuals that paper production caused clearcuts through higher demand for roundwood. It was soundly presented by some participants in their comments to certain narratives.

The narratives represent just a part (though extended) of the communication tools spectrum. Topinnen and Hänninen (2013) studied an emerging phenomenon of the social media application to

communicate corporate responsibility as well as build corporate legitimacy and stakeholder trust in the global pulp and paper industry. This phenomenon despite of its short existence gained popularity for making stakeholder communication easier and more interactive. Thus, further research is needed to better understand stakeholders' needs (suitable for society) and build trustful relations between public and business subjects

Acknowledgements: The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, Grant No. 1/0756/16 Identification of consumers' segments according to their affinity for environmental marketing strategies of businesses entities in Slovakia.

REFERENCES

1. Kaputa, V., Paluš, H., Vlosky, R. (2016): Barriers for wood processing companies to enter foreign markets: a case study in Slovakia. In European journal of wood and wood products. ISSN 0018-3768, 2016, vol. 74, no. 1: pp. 109-122. DOI: 10.1007/s00107-015-0954-5. URL: http://link.springer.com/article/10.1007%2Fs00107-015-0954-5
2. Dvořáček, J., Maťová, H. (2013): CSR Concept and the Value Crisis. In Intercathedra No 29/1. Poznań, Poland. 2013: pp. 37–39. ISSN 1640-3622.
3. Kaputa, V. (2013): Trh a environmentálne atribúty výrobkov z dreva / Market and environmental attributes of wood products. Scientific monograph, Zvolen: Technical University in Zvolen, 2013: p. 56. ISBN 978-80-228-2620-4.
4. Paluš, H., Maťová, H., Kaputa, V. (2012): Consumer preferences for joinery products and furniture in Slovakia and Poland. In Acta Facultatis Xylologiae, N. 54(2), 2012. Technical University in Zvolen: pp. 123-132. ISSN 1336-3824.
5. Paluš, H., Parobek, J. (2011): Changes in competitiveness of selected clusters in the Slovak forest sector. In Development trends in economic and management in wood processing and furniture manufacturing : International Scientific Conference, Kozina, Slovenia : proceedings / ed. Matej Jošt. Zagreb; Ljubljana : International Association for Economics and Management in Wood Processing and Furniture Manufacturing - WoodEMA : University of Ljubljana, 2011: pp. 155-159. ISBN 978-961-6144-31-5.
6. Paluš, H., Parobek, J. (2012): Analysis of the use of raw wood material in the pulp and paper industry in Slovakia. In Intercathedra. No. 28/1 (2012): pp. 67-70. ISSN 1640-3622.
7. Parobek, J. (2010): Recent state in global markets for pulp and paper. In Intercathedra No. 26: pp. 99–101. ISSN 1640-3622.
8. Seisto, A., Federley, M., Aikala, M. (2014): End user views on the environmental sustainability of print media. VTT, Finland, PL 1000, FI-02044 VTT. Extended abstract of the IARIGAI conference 2014 and the COST FP1104 meeting in Swansea, UK.
9. Šupín, M. (2011): Analýza vplyvu globalizácie na slovenský drevársky priemysel v prvej dekáde 21. storočia. In Marketing and trade 2011 : vplyv volatility a interdependencie v svetovom hospodárstve na marketing a obchod. Zvolen : Bratia Sabovci, 2011: pp. 282-286. ISBN 978-80-89241-41-5.
10. Šupín, M. (2011): The measurement of globalization influence on pulp and paper products international trade flows in Slovakia. In Intercathedra No. 27/1: pp. 63–68. ISSN 1640-3622.
11. Toppinen, A., Hänninen, V. (2013): Sustainability management with traditional and innovative social media communication tools. In The Proceedings of The XXIV ISPIM Conference - Innovating in Global Markets: Challenges for Sustainable Growth.

Authors address:
Kaputa, Vladislav*; Šupín, Mikuláš; Kršáková, Anna
Department of Marketing, Trade and World Forestry, Faculty of Wood Sciences and Technology,
Technical University in Zvolen, Slovakia
*Corresponding author: kaputa@tuzvo.sk

EFFECTS OF THE GREAT RECESSION ON PRIMARY AND VALUE-ADDED WOOD PRODUCTS INDUSTRY SECTORS: A CASE STUDY IN LOUISIANA, USA

Vlosky, R.; Abhishek, B.

ABSTRACT

In 2008 and 2015, matched studies were conducted to identify changes in the Louisiana primary and secondary wood products industries. Specifically, the objective was to see if these sectors had recovered from the economic recession of 2007-2008. Results show that from 2007 to 2014, the number of Louisiana primary mills was estimated to have declined 21.5% from 200 to 157 and the number of Louisiana secondary mills estimated to have declined 22.5% from 458 to 354. As housing starts recovered, the percent of remaining softwood and hardwood lumber mill respondents producing these products increased 49% and 46%, respectively. Total full-time employment in the primary sector is estimated to have declined 17% and part-time employees declined 85% over this period. In the secondary sector, production of key products was essentially unchanged. Part-time employment declined 26% but full-time employment increased 9%, likely due to the strength of the repair and remodel sector which actually surpassed single-family housing starts as the number one demand sector for lumber in 2015.
Key words: recession, wood Products, Louisiana, primary sector, secondary sector

1. OVERVIEW

Throughout the human history wood has played an important role due to its wide range of utility and function. Wood has been used in as material for fuel, transportation and shelter. Lumber obtained from wood may have been the most important product after fuel. The technological innovations during the industrial revolution dramatically increased sawmilling efficiencies and improve lumber product quality.

Solid wood products can be classified further into primary and secondary wood products. Primary products are produced directly from raw timber input. Examples include chips, lumber, veneer, plywood and their by-products. Secondary products use primary products as input for re-manufacturing. Secondary wood products industry includes furniture, cabinetry, flooring, millwork, pallets, and railroad tie manufacturing (Vlosky and Chance, 2000).

1.1 Primary wood products in the U.S.

Historically, primary wood products industry in the United States has relied on homebuilders and repair/remodeling contractors as its target customer base. Timber production in the southeastern United States has grown in absolute and relative terms to other regions of the country since the 1970's. At the turn of the twenty first century, the South produced about sixty percent of all wood products in the US . The US is a large net importer of softwood lumber and the majority of lumber imports are from Canada. In the twentieth century, primary wood processing/lumber producing industry has increased its wood utilization rate from 25-30 percent of the log to over 50 percent of the log (Wagner and Hansen 2005).

The North American sawmilling industry has been traditionally commodity product oriented. The firms have focused on producing at the lowest cost and improving processing efficiency (Knowles and Hansen, 2008). With increasing globalization and foreign competition North American sawmilling industry has struggled to remain competitive.

According to U.S. Federal Reserve Economic Data (FRED), seasonally adjusted annual housing starts in the U.S. reached a peak of 2.2 million in the 2005-2006 period (Figure- 1). At this time, the wood products industry was extremely healthy with record production and employment. However, the "Great Recession" of 2007-2008 marked two consecutive years of significant reductions in housing starts, severely harming U.S. forest products sector, both primary and secondary. Housing starts have never fully recovered and are hovering around one million starts annually.

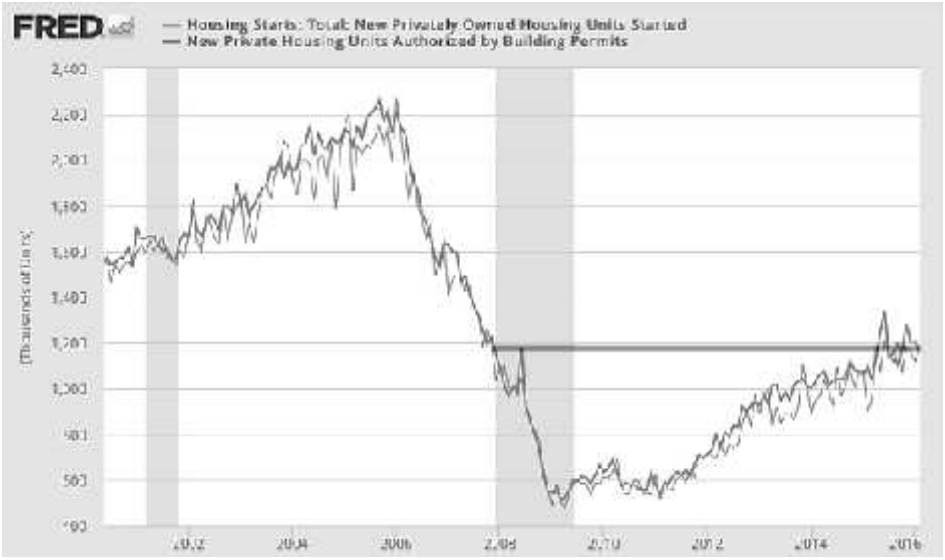


Figure 1- U.S. Housing Starts 2000-2016 (Q1)

Exports of wood products from the United States have seen an upward trend in the last decade. However, as compared to value of wood products imports, the value exports is much smaller. During recession value of exports declined to around $4 billion, however the exports reached its highest level to around $7.5 billion last year. The potential for substitution between timber and other materials depends upon the level of technology and relative prices of alternative material inputs.

1.2 Secondary wood products in the U.S.

As with most of the secondary wood products industry in the United States, wood furniture production is characterized by a large number of small firms using labor-intensive operations while incurring high raw material and transportation costs. The wood product manufacturing is one of the important manufacturing industries in the United States. In 2003 the U.S. wood industry employed over half a million people (U.S. Census Bureau 2005). In 2003 it accounted for approximately $5 billion of exports, while in 2014 the wood product exports reached around $7 billion (U.S. Census Bureau 2015). Even though the U.S. wood industry has remained competitive it has been facing increasing competition from offshore producers in recent years. Packing and shipping innovations such as ready-to-assemble and knock-down furniture have helped accelerate the trade. Emerging Asia-Pacific and South American countries have been increasing their exports to the U.S. Wooden furniture imports to the US have been increasing steadily over the last few decades. In 2014 wooden furniture imports were the highest since the U.S recession with the value of wood imports at over $33 billion (U.S. Census Bureau, 2015). For hardwood products manufacturers, raw material cost accounts for more than 50% of total production cost (Pirraglia et al., 2009).

1.3. Louisiana

Louisiana's forest sector followed this sharp contraction in the national economy that began toward the end of 2007. From 2007 to 2008, total sawlog harvest decreased by 326 million board feet (29%) to a cut of 970.9 million board feet; pine sawtimber harvest decreased by 30%, to a total statewide harvest of 833.2 million board feet, and hardwood sawtimber harvest fell 21% to 137.7 million board feet. Forests cover 14 million acres or almost half of Louisiana . Forests are Louisiana's No. 1 agricultural crop both in terms of gross income and value-added processing. The harvest of timber and allied downstream impacts, contributed $11 Billion in 2012 to the state economy (LSU AgCenter 2015). The solid wood forest products industry consists of approximately 450 enterprises (Louisiana Forest Products Development Center, 2015).

2. THE STUDIES

In an effort to provide information to Louisiana forest industry members, policymakers and other stakeholders, the Louisiana Forest Products Development Center has periodically conducted primary and secondary wood products industry surveys for the past 20 years to identify salient issues, challenges, and opportunities. In 2008 and 2015, a pair of matched studies was conducted to identify changes in the Louisiana primary and secondary wood products industries. Specifically, the objective was to see if these sectors had recovered from the economic recession of 2007-2008.

2.1. Methodology

Using a directory of Louisiana wood products industries compiled by the Louisiana Forest Products Development Center (2015), a census of primary primary and secondary solid wood products companies were surveyed Studies were conducted of Louisiana's wood product sectors in 2007 and 2014.

The studies were conducted using mailed surveys. Survey development and implementation generally followed methods and procedures recommended by Dillman and described as the Tailored Design Method (TDM) (Dillman, 2000). Accordingly, the survey process included a pre-notification postcard, first survey mailing, a reminder postcard, second mailing and, because response rates were not what we expected after two mailings, a third mailing. The questionnaires was pretested with 5-10 wood products manufacturers and revised before the final mailing. Personalized cover letters accompanied the questionnaires were signed by the principal investigator and were addressed to companies/mills by name and address.

After accounting for undeliverable surveys and unusable returned surveys, in 2007, 658 surveys were sent with a response rate of 14%. In 2014, 511 surveys were sent with a response rate of 19%. The respondents were not necessarily the same between the two years, and no paired comparisons were made. The response rates were lower than we have experienced in past years. Although Jones and Lang (1980) point out that increasing the response rate does not necessarily improve the precision of survey results, we feel the results can be considered as being exploratory (Adams, 1986, Hochstim, 1967).

Walonick (1993) believes that most researchers view non-response bias as a continuum, ranging from fast responders to slow responders (with non-responders defining the end of the continuum). Research has shown that late respondents typically respond similarly to non-respondents. Accordingly, second mailing respondents, as a proxy for non-respondents, were compared to first mailing respondents to test for non-response bias (Donald 1960). Of the 54 comparable variables, differences was detected at α=0.05 for four variables (7 percent).

3. RESULTS

3.1 Primary products

Figure 2 shows the percent of respondents manufacturing primary products. Multiple responses were possible as some companies are diversified and produce more than one product. Softwood lumber is the highest ranked product in both periods. The depressed housing markets accompanied a decline in softwood lumber production in the U.S.; however, this rebounded in the subsequent seven years as housting starts rebounded.

The same pattern exists for hardwood lumber and softwood plywood, both tied to housing construction and downstream value-added products that are used in new housing.

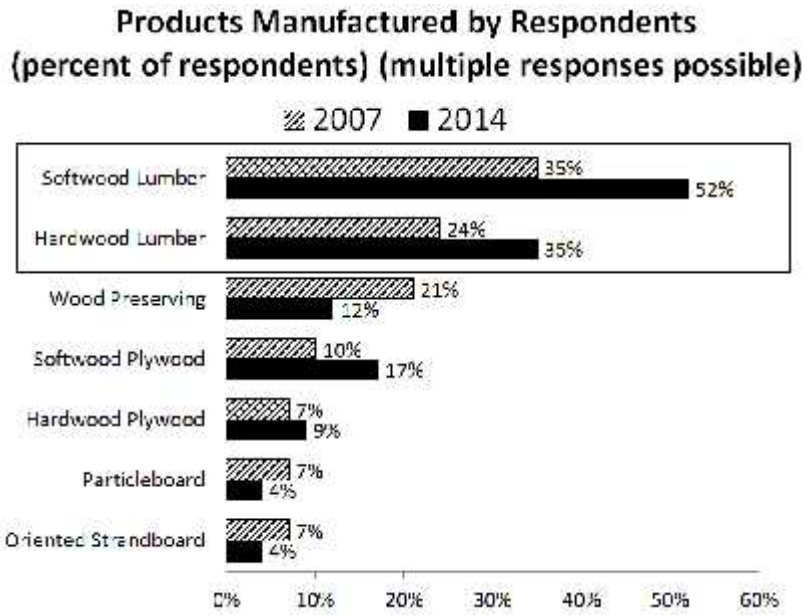


Figure 2- Louisiana Primary Products Sector (2007:n=29; 2014:n=23)

For the primary sector, the total number of part-time employees is estimated to have decreased 85 percent while full-time employees decreased almost 17 percent indicating that this sector has not rebounded from the recession (Figure 3).

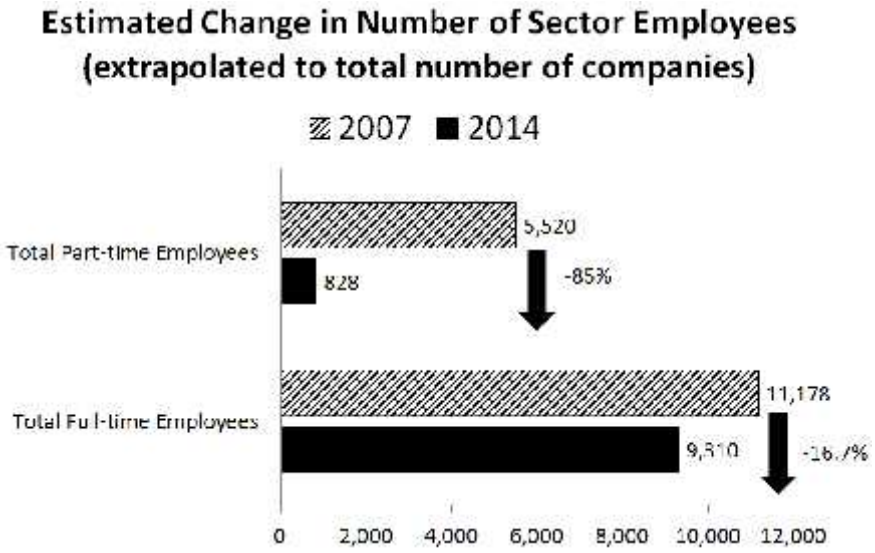


Figure 3- Louisiana Primary Products Sector (2007:n=29; 2014:n=23)

Companies in each sector were asked if they planned to increase employees over the next year. In 2007, for the primary sector, 33 percent of respondents said yes with an average increase per company of eight employees (Figure 4). In 2014, the percent of companies saying yes declined to 27 percent, but the average number of employees anticipated to be added per company, on average, was 13. This suggests a mixed sentiment of whether the housing economy will increase or not.

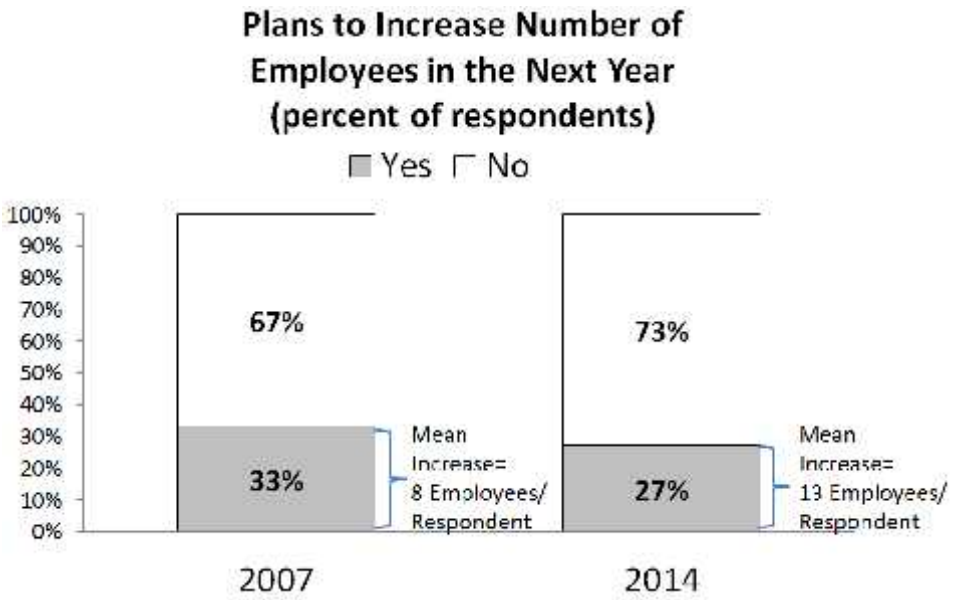


Figure 4- Louisiana Primary Products Sector (2007:n=29; 2014:n=23)

Respondents were asked reasons they did not have plans to increase employees over the subsequent five years. For the primary sector, in 2007, the main reason was "Lack of Markets," which corresponds to the decline in housing starts (Figure 5). However in 2014, the main reason was "Workmen's Compensation Costs" followed by "Can't Find Adequate Labor." With layoffs in the sector, many past employees went on to other careers or retired.

Reasons for not having plans to hire new employees (percent of respondents)(multiple responses possible)
(2007: n=29; 2014: n=23)

	2007	2014	
Lack of markets for my company's products	28%	22%	Workmen's compensation costs
Can't find adequate labor	21%	26%	Can't find adequate labor
Workmen s compensation costs	17%	4%	Can't afford to train employees
State taxes	17%	30%	Labor health costs are too high
I do not want to grow the company	14%	26%	Wages required to hire new employees
Labor health costs are too high	14%	13%	I do not want to grow the company
Federal taxes	4%	9%	Federal taxes
Local taxes	3%	17%	State taxes
Can't afford to train emp oyees	3%	13%	Local taxes
Wages required to hire new employees	0%	9%	Lack of markets for my company's products

Figure 5- Louisiana Primary Products Sector (2007:n=29; 2014:n=23)

Finally, respondents were asked what the challenges were for their companys' success (Figure 6). Every possible challenge was worse in 2007 with the recession (national economy) being the most significant challenge. Getting consistent raw materials was also significant as many forest landowners shifted logs to overseas markets.

Figure 6- Louisiana Primary Products Sector (2007:n=29; 2014:n=23)

3.2 Secondary products

Respondents in the secondary industry manufacture a wide range of value-added products (Figure 7). In this case as well, multiple responses were possible. Cabinets were the main produced in 2007 with 69 percent of respondents, followed by molding and millwork (47 percent). The types of producers did not change as dramatically as in primary products with the exception of furniture which saw an increase from 28 percent of respondents to 40 percent.

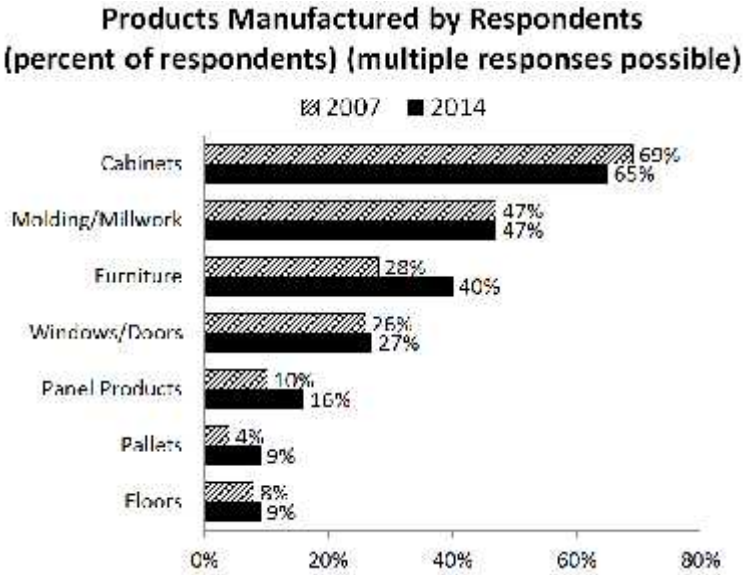


Figure 7- Louisiana Secondary Products Sector (2007:n=51; 2014:n=44)

For the secondary sector, part-time time employees are estimated to have decreased 26 percent with full-time employees increasing nine percent (Figure 8). Although the secondary sector is tied to new housing starts, it is possible that manufacturers have either developed new markets or have shifted production to the repair and remodel demand sector.

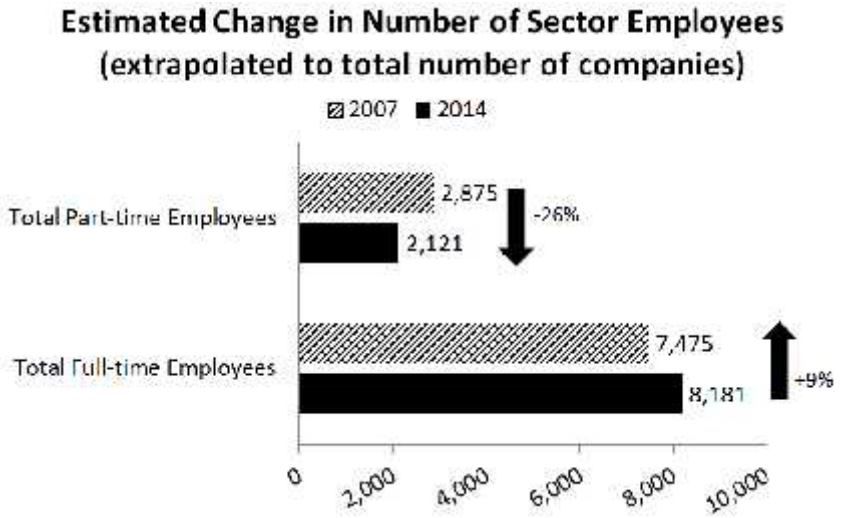


Figure 8- Louisiana Secondary Products Sector (2007:n=51; 2014:n=44)

The percent of companies that indicated plans to increase employees over the next year declined from 38 percent in 2007 to 27 percent in 2014. In this case, a concurrent decline in the anticipated average number of employees to be added declined marginally as well between 2007 and 2014 (Figure 9).

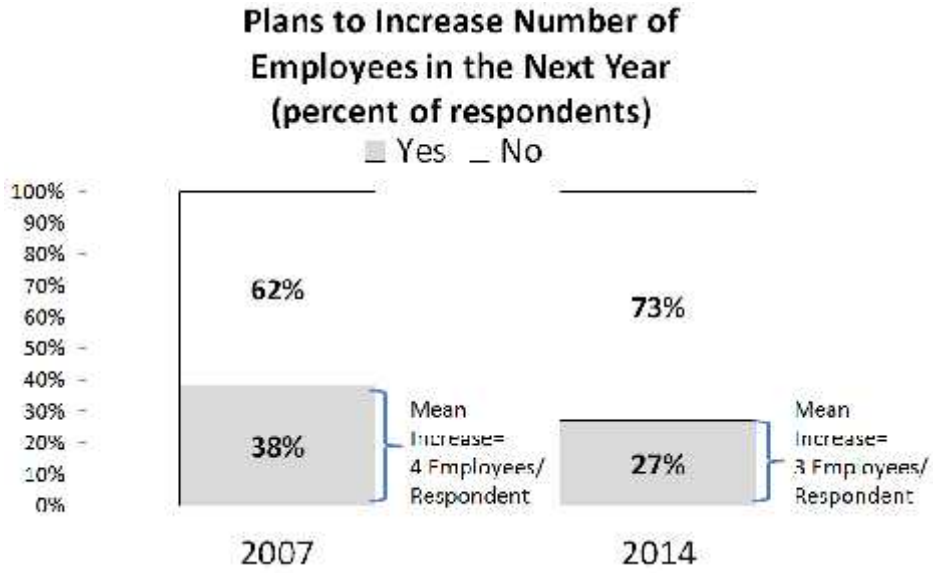


Figure 9- Louisiana Secondary Products Sector (2007:n=51; 2014:n=44)

Secondary respondents were also asked reasons they did not have plans to increase employees over the subsequent five years. In 2007, the main reason was “Lack of Markets,” which again, corresponds to the decline in housing starts (Figure 10). However in 2014, the main reason was “Can’t Find Adequate Labor” followed by “Workmen’s Compensation Costs” and “Wages Required to Hire New Employees”.

Reasons for not having plans to hire new employees
(percent of respondents)(multiple responses possible)
(2007: n=51; 2014: n=44)

	2007		2014	
Lack of markets for my company's products	28%		34%	Can't find adequate labor
Workmen's compensation costs	28%		31%	Workmen's compensation costs
Can't find adequate labor	26%		25%	Wages required to hire new employees
Can't afford to train employees	20%		22%	I do not want to grow the company
Labor health costs are too high	18%		21%	Labor health costs are too high
Wages required to hire new employees	18%		16%	Lack of markets for my company's products
I do not want to grow the company	14%		11%	State taxes
State taxes	10%		11%	Local taxes
Local taxes	10%		9%	Can't afford to train employees
Federal taxes	4%		9%	Federal taxes

Figure 10- Louisiana Secondary Products Sector

As was the case with the primary products manufacturers, secondary manufacturers identified the National Economy as the most significant challenge in 2007, also followed by raw material issues (Figure 11). International Competition and Energy Prices were also significant but declined in importance dramatically in 2014.

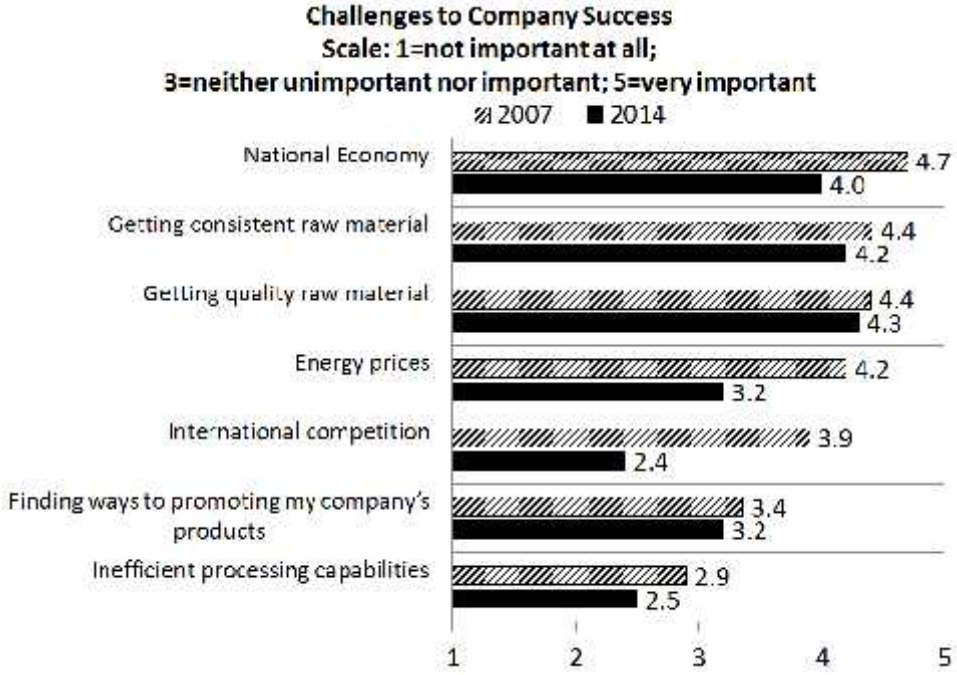


Figure 11- Louisiana Secondary Products Sector (2007:n=51; 2014:n=44)

4. SUMMARY

The recession had a negative influence on Louisiana's primary and secondary wood products sectors. The number of mills in each sector declined by over 20%. Full-time employees in the primary sector declined almost 17% due to strong link to housing starts. The secondary sector increased by 9%, suggesting less of a linkage to starts. In 2008, "Lack of Markets" was the most significant barrier to hiring new employees in both

sectors; in 2014 cost issues became more important. The National Economy was a significant Barrier to Success for both sectors but has declined in importance in 2014. Both sectors are still facing challenges and will continue to do so until housing starts increase and the housing economy stabilizes.

Acknowledgements: We wish to thank Crosby Land & Resources, LLC. For funding these studies.

REFERENCES

1. Adams, J.S. (1986). An experiment on question and response bias. Public Opinion Quarterly 1986; 20: 593-597.
2. Dillman, D.A. (2000). Mail and Internet Surveys - The Tailored Design Method, Second Edition. John Wiley & Sons, New York.
3. Donald, M.N. (1960). Implications of non-response for the interpretation of Mail Questionnaire Data. Public Opinion Quarterly, 24:99-114.
4. Hochstim, J.R. (1967). A critical comparison of three strategies of collecting data from households. Journal of the Statistical Association. 62(9):967-989.
5. Jones, W., and J. Lang (1980). "Sample composition bias and response bias in a mail survey: A comparison of inducement methods." Journal of Marketing Research 17:69-76.
6. Knowles, C., and E.N. Hansen (2008). "Assessing innovativeness in the North American softwood sawmilling industry using three methods." Canadian Journal of Forest Research 38 (2): 363-375.
7. LSU AgCenter. (2015). Louisiana Summary – Agriculture & Natural Resources 2008. Louisiana State University Agricultural Center. Baton Rouge, LA. Page 16.
8. Louisiana Forest Products Development Center. (2015). Louisiana Forest Industries Website. www.lsuagcenter.com/forestindustries.
9. Pirraglia, A.,D. Saloni and H. Van Dyk (2009). "Status of lean manufacturing implementation on secondary wood industries including residential, cabinet, millwork, and panel markets." BioResources 4 (4): 1341-1358.
10. U.S. Census Bureau (2005). Statistics for Industry Groups and Industries: 2003.
11. U.S. Census Bureau (2015). U.S. International trade statistics.
12. U.S. Department of Commerce (1993). Statistical Abstract of the United States. Washington D.C.
13. Vlosky, R. P. and N. P. Chance (2000). Industry Structure and Market Potential for Value-added Wood Products in Northwest Louisiana, Louisiana Agricultural Experiment Station, LSU Agricultural Center.
14. Wagner, E. R. and E. N. Hansen (2005). "Innovation in large versus small companies: insights from the US wood products industry." Management Decision 43 (6): 837-850.
15. Walonick, D. (1993). Everything You Wanted to Know about Questionnaires but Were Afraid to Ask. http://www.statpac.com/research-papers/questionnaires.htm (Accessed April 28, 2015).

Corresponding Author:
Richard P. Vlosky, Ph.D., Director, Louisiana Forest Products Development Center
Crosby Land & Resources Endowed Professor of Forest Sector Business Development
Room 227, School of Renewable Natural Resources, Louisiana State University, Baton Rouge, LA 70803
Phone (office): (225) 578-4527; Fax: (225) 578-4251; Mobile Phone: (225) 223-1931
E-mail: vlosky@lsu.edu

CSR, BUSINESS AND MARKETING AND INNOVATION IN FOREST POLICY AND SUSTAINABILITY IN THE FOREST-BASED MARKETS WITH STAKEHOLDERS

Hyytiä, A.

ABSTRACT

In the value chain, forest products represent opportunities in the competitiveness and sustainable development. The role of certification in the sustainable development internationally and nationally is significant. Forest certification belongs to the green communication. Synergy between the policies is highlighted in the European Union. Innovations and quality are important in competitiveness. Private investments and stakeholder collaboration are highlighted in the EU Bio-economy Strategy. CSR is in a remarkable role enhancing the sustainable development and competitiveness in the policy framework. This is a qualitative research based on literature.

Key words: Forests and forest products, Sustainable development, CSR, Business, Marketing, Innovation, Competition, Policy

1. THEORETICAL FRAMEWORK

Stakeholder theory is a profitable tool in the Corporate Social Responsibility, CSR. The CSR has developed as a globally accepted wide concept and cooperation approach in which climate change framework and sustainability issues can be discussed. (Wang, Lei and Juslin, Heikki 2011) The roles of innovation and sustainability can be accentuated in the bioeconomy and the forest sector. The role of business has extended in the concept of Corporate Social Responsibility, CSR. A specific policy setting has a demand. (Kleinschmidt et al. 2014) Overall, sustainable development orientation is seen preferable for corporations the outcome of which is corporate responsibility with strong sustainability. (Heikkurinen, Pasi and Bonnedahl, Karl Johan 2013). Sustainable Market Orientation offers the potential for remarkable benefits for primary and secondary stakeholders of a corporate (Mitchell et al. 2010). Market driven demand for forest certification schemes in a corporation is found significant (Tuppura, Anni et al. 2015)

Private sector can have an important role in resource supply providing opportunities for competition (Schmithüsen et al. 2014, p. 58) Certification is a good example of a market pathway influencing policy making. (Cashore et al. 2014) Certification schemes can enable to regulate markets (Bernstein, Steven and Cashore, Benjamin 2012).

2. SUSTAINABLE DEVELOPMENT IN BUSINESS AND INNOVATION WITH RESOURCES AND POLICY INTERNATIONALLY

Corporations have a role in the sustainable development, responsible business, innovation and collaboration (Agenda 2030: the Sustainable Development Goals 2015). European Union has a strategy on the CSR which is the European Commission Strategy on CSR. The EU Commission is managing the CSR in cooperation with stakeholders. (Growth – CSR 2015).

CSR with responsable business has a significant role in the sustainable development (COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A renewed EU strategy 2011-14 for Corporate Social).

Customer point of view is significant; international understanding of service-related demand by customers is significant (Toivonen, Ritva 2011). International competition is challenging and there are substitutive products. Targeted marketing and branding are highlighted. (Tokarczyk, John and Hansen, Eric 2006)

Europe's Bio-economy strategy in 2012 strives for innovations and enhancing stakeholder engagement as well as markets and competitiveness (The Bioeconomy Strategy 2012). In the sustainable development in the forest sector with stakeholders, there are promising opportunities in the green economy and bio-based products and economy (Forest Products Annual Market Review 2012-2013).

European Union pursues to the sustainable development in trade in the EU and globally. Trade policies and agreements have an important influence on the economy, as well as social and environmental aspects, including policy development and regulatory aspects. (Trade – Sustainable development 2015)

Forests in the European Union are subordinated to national laws and international commitments in the strive for the sustainability. Sustainable forest management can be secured by certification. (Growth – Internal Market, Industry, Entrepreneurship and SMEs – Sustainable Forest Management 2015).

3. ROLE OF CORPORATIONS

Forest certification with the chain-of-custody (CoC) certification will be a prerequisite for market access. It represents ethical trade and social responsibility and has a role in combating climate change. It is a soft policy instrument promoting the sustainable forest management and consumption of forest products. Certification and labelling are innovative policy instruments. With the sustainable forest management it conforms the green economy policy. (Muthoo, Maharaj K. 2012)

"Forests in the ECE Region - Trends and Challenges in Achieving the Global Objectives on Forests" highlights the role of the EU FLEGT and VPAs in promoting sustainable production and use of forest products and attaining sustainable forest management. Framework of carbon stocks and preventing deforestation in the tropical forests are highlighted. Certification schemes are instruments of the private sector. They contain standards for sustainable forest management, audits by the third-party in the forest management, chain-of-custody and product labelling. (Forests in the ECE Region - Trends and Challenges in Achieving the Global Objectives on Forests 2015)

The EU Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT) in 2003 includes a process and plan of the European Commission proposed to the widening problem of illegal logging and trade related to it. It develops multilateral collaboration and covers dialogue with countries producing and consuming wood and involves measures that are proposed to promote private sector initiatives in the forest sector striving for legal timber. (COMMUNICATION FROM THE COMMISSION

TO THE COUNCIL AND THE EUROPEAN PARLIAMENT FOREST LAW ENFORCEMENT, GOVERNANCE AND TRADE (FLEGT) PROPOSAL FOR AN EU ACTION PLAN 2003).

It is expected that combating illegal logging by the Regulation contributes to the European Union's efforts in climate change mitigation complementing a commitment in the framework of the United Nations Framework Convention on Climate Change (Regulation [EU] No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market 2010).

The certification by the third-party organisation with assessment and accreditation process according to standards of the ISO is highlighted (Guidance document on the EU timber regulation 2016).

EU Timber Regulation's significance can be accentuated in the value chains in the forest sector. Green practices and communication are highlighted. (Holopainen, Jani et al. 2015)

4. CONCLUSIONS

Corporations have significant and multiple roles in the CSR and in sustainable development. Forest certification and the CSR with Forest Law Enforcement, Governance and Trade FLEGT Regulation and legality of timber and timber products give a new role for stakeholders and companies in markets. Stakeholder collaboration may enhance the policy framework. Green communication is in a significant role. Forest Law Enforcement, Governance and Trade FLEGT can give a response to the CSR and stakeholder approach in the forest-based sector in the sustainable development framework. It has significance for national and international markets and the sustainable development framework. It links to the competitive markets. By sustainable forest management and forest products, the green initiatives can be in a sustainable green communication framework represented by stakeholders. Enhancing business and competitiveness with sustainable goals with stakeholders can meet the goals of green policies and strategies.

REFERENCES

1. Agenda 2030: the Sustainable Development Goals 2015. Available at: https://www.unglobalcompact.org/what-is-gc/our-work/sustainable-development/sdgs.
2. Barney, J. B. 2002. Gaining and Sustaining Competitive Advantage (Second edition). Pearson Education Inc. Upper Saddle River (NJ): Prentice Hall, 2002.
3. Bernstein, Steven and Cashore, Benjamin 2012. Complex global governance and domestic policies: four pathways of influence. 2012. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2346.2012.01090.x/pdf.
4. Cashore et al. 2014. Cashore, Benjamin, Pohnan, Erica and Stone, Michael W. Impact of Globalization of Forest Users: Trends and Opportunities. In: Global Forest Sector. Changes, Practices, and Prospects. Ed. Hansen, Eric, Panwar, Rajat, Vlosky, Richard. 2014. CRC Press. Available at: http://www.crcnetbase.com/isbn/9781439879283.
5. Cashore, Benjamin and Stone, Michael W. 2012. Can legality verification rescue global forest governance? Analyzing the potential of public and private policy intersection to ameliorate forest challenges in Southeast Asia. Available at: http://www.sciencedirect.com/science/article/pii/S1389934111001961.
6. COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT FOREST LAW ENFORCEMENT, GOVERNANCE AND TRADE (FLEGT) PROPOSAL FOR AN EU ACTION PLAN 2003. Available at: http://www.fao.org/forestry/33093-04ee4b3cc7232ef705169b9cc20c30850.pdf.
7. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A renewed EU strategy 2011-14 for Corporate Social Responsibility Social Business Initiative. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0681:FIN:en:PDF.

8. Forest Products Annual Market Review 2012-2013. UNECE/FAO Forest Products Annual Market Review, 2012-2013. Geneva Timber and Forest Study Paper 33. ECE/TIM/SP/33. Available at: https://www.unece.org/fileadmin/DAM/timber/publications/FPAMR2013.pdf.
9. Forests in the ECE Region - Trends and Challenges in Achieving the Global Objectives on Forests 2015. United Nations Publications. ECE/TIM/SP/37. Available at: http://www.unece.org/fileadmin/DAM/timber/publications/forests-in-the-ece-region.pdf. ECE/TIM/SP/37.
10. Growth – CSR 2015. Available at: http://ec.europa.eu/growth/industry/corporate-social-responsibility/index_en.htm.
11. Growth – Internal Market, Industry, Entrepreneurship and SMEs – Sustainable Forest Management 2015. Available at: http://ec.europa.eu/growth/sectors/raw-materials/industries/forest-based/sustainable-forest-management/index_en.htm.
12. Guidance document on the EU timber regulation 2016. Available at: http://ec.europa.eu/environment/forests/timber_regulation.htm.
13. Harrinkari, Teemu, Katila, Pia and Karppinen, Heimo 2016. Stakeholder coalitions in forest politics: revision of Finnish Forest Act. Forest Policy and Economics, Volume 67, June 2016, Pages 30–37. Available at: http://www.sciencedirect.com/science/article/pii/S138993411630017X.
14. Heikkurinen, Pasi and Bonnedahl, Karl Johan 2013. Corporate responsibility for sustainable development: a review and conceptual comparison of market- and stakeholder-oriented strategies. Journal of Cleaner Production. Volume 43, March 2013, Pages 191–198. Available at: http://www.sciencedirect.com/science/article/pii/S0959652612006671.
15. Holopainen, Jani et al. 2015. Holopainen, Jani, Toppinen, Anne and Perttula, Sini. Impact of European Union Timber Regulation on Forest Certification Strategies in the Finnish Wood Industry Value Chain. Forests 2015, 6(8), 2879-2896; doi:10.3390/f6082879. Available at: http://www.mdpi.com/1999-4907/6/8/2879.
16. Innovating for Sustainable Growth: A Bioeconomy for Europe 2012. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. {SWD(2012) 11 final}. EUROPEAN COMMISSION. Brussels, 13.2.2012. COM(2012) 60 final. Available at: http://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf.
17. Kleinschmidt et al. 2014. Kleinschmidt, Daniela, Lindstad, Berit Hauger, Thorsen, Jellesmark Bo, Toppinen, Anne, Roos, Anders and Baardsen, Sjur. Shades of green: a social scientific view on bioeconomy in the forest sector. Scandinavian Journal of Forest Research. Volume 29, Issue 4, 2014. Special Issue: Biobased Economy. Available at: http://www.tandfonline.com.libproxy.helsinki.fi/doi/pdf/10.1080/02827581.2014.921722.
18. KOMISSION ASETUS (EY) N:o 1024/2008, annettu 17 päivänä lokakuuta 2008. KOMISSION ASETUS (EY) N:o 1024/2008, annettu 17 päivänä lokakuuta 2008 KOMISSION ASETUS (EY) N:o 1024/2008, annettu 17 päivänä lokakuuta 2008yksityiskohtaisista toimenpiteistä Euroopan yhteisöön suuntautuvaa puutavaran tuontia koskevan FLEGT-lupajärjestelmän perustamisesta annetun neuvoston asetuksen (EY) N:o 2173/2005 täytäntöön panemiseksi. Available at: http://eur-lex.europa.eu/legal-content/FI/TXT/PDF/?uri=CELEX:32008R1024&from=EN.
19. Li, Ning 2012. A quest for corporate sustainability in forest-based industry: a resource-based perspective. Department of Forest Sciences. Faculty of Agriculture and Forestry. Dissertation Forestales 150. 2012. Available at: http://www.metla.fi/dissertationes/df150.pdf.
20. Mitchell et al. 2010. Mitchell, Robert W., Wooliscroft, Ben and Higham, James. Sustainable Market Orientation: A New Approach to Managing Marketing Strategy. Journal of Macromarketing 30(2) 160-170. Available at: http://jmk.sagepub.com/content/30/2/160.full.pdf+html.
21. Muthoo, Maharaj K. 2012. Unasylva 239, Vol. 63, 2012/1. Available at: http://www.fao.org/docrep/017/i2890e/i2890e04.pdf.
22. Regulation [EU] No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market 2010. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010R0995&from=EN. http://ec.europa.eu/environment/forests/timber_regulation.htm.
23. Schmithüsen et al. 2014. Entrepreneuship and Management in Forestry and Wood Processing. Principles of business economics and management processes. Schmithüsen, Franz, Kaiser, Bastian, Schmidhauser,

Albin, Mellinghoff, Stephan, Perchthaler, Karoline and Kammerhofer, Alfred W. Routledge explorations in environmental economics.
24. The Bioeconomy Strategy 2012. Available at: http://ec.europa.eu/research/bioeconomy/policy/strategy_en.htm.
25. Toivonen, Ritva 2011. Dimensionality of quality from a customer perspective in the wood industry. Available at: http://www.metla.fi/dissertationes/df114.htm.
26. Tokarczyk, John and Hansen, Eric 2006. Creating Intangible Competitive Advantages in the Forest Products Industry. Forest Products Journal 56.7/8 (Jul/Aug 2006): 4-13. Available at: http://www.unece.lsu.edu/ebusiness/documents/2007July/SC_013.pdf.
27. Trade – Sustainable development 2015. Available at: http://ec.europa.eu/trade/policy/policy-making/sustainable-development/.
28. Tuppura, Anni et al. 2015. Tuppura, Anni, Toppinen, Anne and Puumalainen, Kaisu. Forest Certification and ISO 14001: Current State and Motivation in Forest Companies. Business Strategy and the Environment. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/bse.1878. Available at: http://onlinelibrary.wiley.com/doi/10.1002/bse.1878/pdf.
29. Wang, Lei and Juslin, Heikki 2011. Corporate Social Responsibility and Environmental Management. Corp. Soc. Responsib. Environ. Mgmt. 20, 129–145 (2013). Published online 12 December 2011 in Wiley Online Library. (wileyonlinelibrary.com) DOI: 10.1002/csr.286. Available at: http://onlinelibrary.wiley.com/doi/10.1002/csr.286/pdf.

Authors address:
Hyytiä, Annika*[1]
[1] Department of Forest Sciences, Faculty of Agriculture and Forestry, University of Helsinki, Helsinki, Finland
*Corresponding author: Annika.hyytia@helsinki.fi

CSR AND LEGISLATION FRAME IN THE SLOVAK REPUBLIC

Dvořáček, J.; Dovčíková, A.

ABSTRACT

The article deals with the issue of the CSR of a wood processing company in parallel with the current legislation in the Slovak Republic. It is based on the premise that if the company conforms to the current legislation, it still does not mean that it acts socially responsibly. The analysis describes the most fundamental laws and regulatory standards affecting business of wood processing companies and consecutively is determined legislation frame of CSR in the Slovak republic.

Key words: Corporate Social Responsibility, legislation, regulatory standards, wood processing company

1. INTRODUCTION

At the present time the CSR topic can't be regarded as an entirely new, but it certainly can be regarded as still highly topical in any sector of the national economy. Many companies in their public announcements declare business in accordance with the principles of CSR, but in many cases it is often referred to the compliance with current legislation and not about the CSR. The definitions of CSR emphasize voluntariness and implementation of activities that go beyond the current legislation. European Commission in Green Paper (2001, p. 6) defines CSR as an initiative based on the "voluntary integration of social and environmental considerations into everyday corporate activities and interactions with company stakeholders." A brief, but very appropriate characteristics of CSR mentioned Trnková (2004, p. 9), which states that "the concept of CSR is characterized by providing of added value and implementation of management visions that go beyond the current legislation". The company that only complies with the law can't be considered as socially responsible, although many companies are presenting their selves like that. This phenomenon, however, can be seen as a problem of CSR globally and not only in the Slovak Republic. Equally, we can still meet the opposite situation that companies voluntarily carry out activities beyond the law, but they absolutely do not inform about their actions, nor their stakeholders and even the general public. The main reason is persistent ignorance of CSR. According to a survey by KPMG in 2015, to 92% of the 750 largest companies in the world publish reports on CSR. Overall, about sustainability informs 73%, while in 1993, do so only 13% of companies. The Slovak companies are far behind; in 2015 published a sustainability report only 45% of companies (Furik, 2016). It also reports about the low awareness of CSR among Slovak entrepreneurs, including forest industry.

The aim of this article is to describe the institutional conditions for CSR in the Slovak Republic and the basic legislative framework affecting business of wood processing companies with regard to the three areas of CSR: economic, social and environmental.

1.1. Importance of forest industry for the Slovak economy

Forest industry is one of the sectors in which the Slovak economy may at least partly influence European markets with maximum utilization of its own resources. There is an effort to increase added value and to support domestic consumption of wood commodities. This effort and development of forest industry depends on society-wide interest in the broad context as well as in the narrow context on different stakeholders entering the wood product chain. The wood market in Slovakia is always

developing, and the demand for roundwood is changing depending on the possibilities of its use. There are many specifics influencing production and consumption patterns. On one hand, timber production is subject to available resources, which are the result of long-term forest management and long-term planning, on the other hand, timber production tries to adapt to rapidly changing market conditions and the requirements of wood processing sectors that vary over a relatively short period of time (Parobek et al. 2014). At the present time, besides pulp and paper industry, forest industry producing higher added value e.g. (final wood commodities such as furniture, wood construction, etc.) is, in many cases, still unable to compete on the European market. Therefore production and export of wood and semi-finished products is important part of income for the Slovak forest industry (Parobek et al. 2016).

1.2. Institutional conditions for CSR in the Slovak Republic

In the Slovak Republic does not have the strategy for CSR a form of a separate document, but is a part of the National Strategy for Sustainable Development. This strategy is based on Agenda 21 - the program document of the United Nations. The National Strategy for Sustainable Development defines the strategic objectives and long-term priorities in the field of sustainable development for conditions of the Slovak Republic, defines sustainable development, its principles and criterions. It is a framework document, which essentially identifies opportunities of the Slovak Republic in the field of sustainable development, characterizes the situation in the various areas of sustainable development and defines the fundamental starting point. The individual areas and priorities for sustainable development have been developed also in the Competitiveness Strategy of the Slovak Republic until 2010 - the Lisbon Strategy for Slovakia and in the National Reforms Program of the Slovak Republic in chronological succession from 2006 to the present. This document reflects mainly a way to establish and then to maintain a stable macroeconomic environment and improvement of the business environment. It is dedicated to aspects of smart growth and social inclusion and there are also mentioned the basic aims of sustainable development. National strategy of sustainable development is elaborated in the Sustainable Development Action Plan, which is evaluated annually (Fifeková et al., 2011).

The national authority which ensures the coordination of tasks of sustainable development was until March 2011 the Council of the Slovak Government for Sustainable Development. During its existence was the coordination, advisory and initiative body of the Slovak government for issues concerning the implementation of Agenda 21, the Millennium Development Aims and the Johannesburg Plan of Implementation and European Union policies, mainly the initiatives and programs contributing to the policy of sustainable development, the Lisbon strategy, the European Union and national sustainable development strategy nationwide. In 2011 the Council of the Slovak Government for Sustainable Development was canceled and all of its competencies passed to the newly created Ministerial Council, which represents the ministerial consultative, advisory, initiative and coordination body of the Slovak Government (led by the Prime Minister). This change greatly narrowed the competence of the authorities in the field of sustainable development (Fifeková et al., 2011).

The situation in the coverage of the CSR agenda and Sustainable Development in the Slovak Republic can not be considered satisfactory. In this area is not visible any qualitative movements towards improving of conditions. The takeover of the Sustainable Development problematics by Ministerial Council (March 2011) on the one hand evokes the impression that Sustainable Development problems has more attention and these problems are completely covered from one place. But on the other hand, in the terms of fiscal consolidation may be the objectives of sustainable development postponed or replaced by marginalized stabilization objectives, what greatly decreases possibilities of implementation of projects and activities, especially environmental. Negative can be perceived also the fact that within the government is not formed an independent body that would have the competence for CSR (Fifeková et al., 2011).

1.3. Legislation frame of CSR in the Slovak Republic

The basic legal framework of CSR in Slovakia is given by the Constitution, which guarantees the rights of national minorities and ethnic groups living in the Slovak Republic, the application of democratic principles and approaches, rights, freedom and justice, and defines the Slovak Republic as a socially and ecologically oriented market economy. All laws that are accepted in the Slovak Republic must comply with the Constitution (Fifeková et al., 2011).

The legal framework for CSR is primary related to term business that is in the current legislation defined by the current version of § 2 of the Commercial Code as " systematic activities, which are independently conducted for the purpose of making a profit by an entrepreneur in his own name and at his own responsibility".

The business, respectively its variation, is in the Slovak Republic based on the following legislative provisions:

- Act. 513/1991 Coll. as amended Regulations- Commercial Code,
- Act. 455/1991 Coll. as amended Regulations- Trade Act.

Other laws that the entrepreneur is obliged to follow are (regardless of the type of business):

- Law on Accounting,
- Law on Income Tax
- Health Insurance Act,
- Social Insurance Act.

1.3.1 Economic area

Economic area of business covers the following laws:

- Act. 513/1991 Coll. Commercial Code as amended,
- Act. 455/1991 Coll. Trades Code, as amended,
- Act. 40/1964 Coll. Citizen Code, as amended,
- Act č.431 / 2002 Coll. on Accounting, as amended,
- Act. 530/2003 Coll. on the Commercial Register, as amended,
- Act. 136/2001 Coll. on Protection of Competition, as amended,
- Act. 595/2003 Coll. on Income tax, as amended,
- Act. 211/2000 Coll. Freedom of information
- Act. 250/2007 Coll. Consumer protection
- Act. 25/2006 Coll. on Public Procurement, as subsequently amended,
- Act. 561/2007 Coll. on Investment aid, as subsequently amended.

The largest amount of duties of the Slovak entrepreneurs is covered by Commercial Code. Every entrepreneur whether registered in the Commercial Register, or not, is obliged to keep accounts truthfully and honestly and pays the state compulsory taxes. The entrepreneur registered in the Commercial Register, mostly as a limited liability company or a joint stock company, has an obligation to keep double-entry accounting only. He has the right to participate in the competition on behalf of achievement of economic benefit. The entrepreneurs under the Commercial Code shall not commit the following actions:

- to promote false advertising,
- falsely labeled goods and services,
- to cause confusion,
- to parasitize on the reputation of the company, products or services of another trader,
- to bribe,

- to violate trade secrets.

This means that the entrepreneur can release about his products or services only true information referred to label of origin, date of production, suitability and way of usage. The entrepreneur also has to give only true trade name or mark of the product, to avoid of confusion with another manufacturer.

Since February 2013, following an amendment to the Commercial Code, companies have up to 60 days to repay the invoices within the supplier-customer relations. If there is a delay of payment, the entrepreneur is sanctioned by the basic interest rate of the European Central Bank.

The amendment of the Civil Code and the Law on Free Access to Information define the duty of entrepreneur to publish a contract in the Central Register of contracts, if the contract was made with the ministry, public institution or any governmental institution. Unless it does so within three months, the contract automatically becomes null and void.

According to Law no. 250/2007 on the protection of consumers is the entrepreneur bound to sell products at the right weight or measure and the consumer has the right and must be able to check the correctness of the data.

1.3.2 Social Area

The relationship between the employee and the employer is adapted by several legislative standards. It is not governed coherently only by one legislation standard but the employer is obliged to follow the amount of regulations, laws and regulations. Employer obligations are defined by:

- Act. 311/2001 Coll. Labour Code, as amended,
- Act. 580/2004 Coll. on Health insurance as amended,
- Act. 461/2003 Coll. on Social insurance, as amended,
- Act. 595/2003 Coll. on Income tax, as amended,
- Act. 124/2006 Coll. on Health and safety at work, as amended,
- Act. 283/2002 Coll. on Travel expenses, as amended,
- Act. 355/2007 Coll. on Protection, support and development of public health, as amended,
- Act. 122/2013 Coll. Personal Data Protection, as amended.

The most fundamental employer's obligations to its employees should follow the Labour Code. The first duty which the employer has to future employees is truthfully inform the applicant about his duties, rights, labor conditions and job description. The employer is obliged to grant the day off to an employee in the serious personal issues, such as funerals, childbirth, medical examination and others. The vacation is also granted by an employer. The Labour Code states that an employer may not impose overtime to an employee who performs risky work and work in health damaging environment.

An employee is legally guaranteed that the employer can not give notice at the time of commencement of maternity or parental leave, or is unable to work. The employee, whose working time is longer than six hours, is entitled for a 30 minute break.

Under the Law on Safety and Health at Work, the employer is obliged to provide a safe working environment and appropriate protection for risky professions, which may include the processing of wood raw material. The employer also must take in account human capacities and characteristics by the design of workplace, working procedures and by the choice of working equipment to be eliminated the effects of negative work factors on the employees' health. (eg. monotonousness, excessive noise, …). The employer is obliged to provide employees work clothes and work shoes for free when working in an environment where clothing or footwear is subject of strong pollution or abnormal wear. The employer is obliged to provide employees free drinking regime, if it is necessary to protect the life or health and provide washing, cleaning and disinfecting means necessary to ensure personal hygiene. All costs associated with ensuring safety and health at work should be covered by the employer, these costs may not be transferred to the employee.

1.3.3 Environmental area

Companies' obligations towards the environment are defined by law:

- Act. 543/2002 Coll. on Nature and landscape protection, as amended,
- Act. 137/2010 Coll. Clean Air, as amended,
- Act. 364/2004 Coll. Water, as amended,
- Act. 223/2001 Coll. on Waste, as amended,
- Law no. 8/2009 Coll. Road traffic and on amendments to certain laws,
- Act. 491/2005 Coll. on Environmental verification and registration in the European Community scheme for environmental management and audit, as amended,
- Act. 469/2002 Coll. the Environmental labeling of products, as amended,
- Act. 24/2006 Coll. on the Assessment of environmental impacts, as amended.

From above mentioned laws arise the essential obligations of companies:

Unless the company for its business use a significant landscape element, it can be used only in a way that has not been disturbed its condition and not to threaten or to weaken its eco-stabilizing function. The entrepreneur who plans to carry out activities that may threaten or violate the territorial system is obliged to propose precautions that will contribute to its creation and maintenance. Unless business activity disturbs the ecosystem, its components or elements, the company is obliged on its own expense to take steps that will prevent and limit their damaging.

The company manufacturing or importing regulated products must annually submit to inspection accurate records of the quantity and quality of those products. The company that by its activities pollutes the air is obliged to inform the public and also to inform about the steps implemented to reduce this pollution.

The company that produces by its production waste is obliged to recover the waste by its activities. Every entrepreneur is obliged to dispose with waste in a way that is safe for human health, not damaging the environment and by which can not be:

- risk of pollution of water, air, soil, endangering plants and animals;
- causing a nuisance by noise or odors,
- negative affecting the countryside or places of special interest.

The act on Road traffic influence mainly companies that by their activities using trucks. The law establishes that a vehicle entering the road must be pre-cleaned to not soiling the road. The truck must have a load on the vehicle properly placed, arranged and secured in order to not threaten the safety and flow of traffic and not to harm the road or its surroundings, not cause excessive noise and low-emission. Loading and unloading cargo on the road is permitted only if it can not be done out of the road. The cargo must be unloaded and loaded as quickly as possible and can not to threaten safety of traffic.

2. CONCLUSION

The guarantor of creating of institutional conditions for CSR in the Slovak republic should be national authorities, but the situation in this region can not be considered satisfactory. In this field is not visible any qualitative movements towards improving of conditions and promoting of CSR initiatives. Within the legislative framework should be the obligation of the state to ensure an environment in which all similar initiatives are supported. Space for easy existing of CSR is consisted by an effective and functioning legal state and its components, but the development of CSR should be led by enterprises themselves. Public authorities should play a supporting role through a smart mix of voluntary policy measures and, where necessary, complementary regulation, for example to promote transparency,

creates market incentives for responsible business conduct, and ensures corporate accountability. Enterprises must be given the flexibility to innovate and to develop an approach to CSR that is appropriate to their circumstances. Many enterprises nevertheless value the existence of principles and guidelines that are supported by public authorities, to benchmark their own policies and performance, and to promote a more level playing field.

Acknowledgements: The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences. This paper was elaborated within the frame of Grant project 1/0756/16 “Identification of consumers’ segments according to their affinity for environmental marketing strategies of business entities in Slovakia”

REFERENCES (alphabetical order)

1. ***: European Commission (2001): GREEN PAPER. Promoting a European framework for Corporate Social Responsibility. URL: http://eur-lex.europa.eu/LexUriServ/ LexUriServ.do?uri=COM:2001:0366:FIN:EN:PDF
2. Fifeková, E.; Karabínoš, S.; Lábaj, M. (2011): Úspešnosť Slovenska vo vytváraní podmienok pre spoločensky zodpovedné podnikanie. URL: https://www.employment.gov.sk/files/slovensky/ministerstvo/spolocenska-zodpovednost/sprava-o-vytvarani-pomienok-pre-szp-na-slovensku.pdf
3. Furik, A. (2016): Podnikať zodpovedne sa vypláca. URL: http://euractiv.sk/clanky/csr-spolocenska-zodpovednost/podnikat-zodpovedne-sa-vyplati/
4. Parobek, J.; Paluš, H.; Kalamárová, M.; Loučanová, E.; Križanová, A.; Repková – Štofková, K. (2016): Comparative analysis of wood and semi-finished wood product trade of Slovakia and its central European trading partners. Drewno. Vol. 59, No. 196: pp. 183-194
5. Parobek, J.; Paluš, H.; Šupín, M.; Kaputa, V. (2014): Ananalysis of wood flows in Slovakia. BioResources 9 (4): pp. 6453-6462
6. Trnková, J. (2004): Společenská odpovědnost firem. Kompletní průvodce tématem a Závěry z průzkumu v ČR. URL: http://www.blf.cz/csr/cz/vyzkum.pdf

Authors address:
Dvořáček, Jan[1*]; Dovčíková, Anna[2]
[1 2] Department of Marketing, Trade and World Forestry, Faculty of Wood Sciences and Technology, Technical University in Zvolen, Zvolen, Slovakia
*Corresponding author: dvoracek@tuzvo.sk

FROM EMPIRICAL STUDIES TO BIOENERGY STATISTICS: BRIDGING THE GAP OF UNRECORDED WOOD-BIOENERGY IN GERMANY

Weimar, H

ABSTRACT

The full coverage of all bioenergy based on woody and other solid biomass in energy statistics is a necessity – and a challenge. It is a necessity for e.g. reporting on the development of bioenergy or generally for market transparency. And it is a challenge as especially smaller sectors or smaller plants usually are not monitored by energy statistics. On the other hand, we know – based on various empirical studies on the use of wood for energy generation – for certain data points in time the total use of woody biomass in firing plants. We use both data sources to outline a methodological concept to estimate the unmonitored quantities. Our further objective is to develop a time series of the unmonitored sectors for the period from 2003 to 2014. Calculations were done using regression analysis to estimate best-fit-curves and linear interpolation. Results show that the unmonitored sector has contributed between 23 PJ and 58 PJ of wood energy in the analyzed time period. The share of this sector on the total use of wood for energy production in Germany varies between 10 % and 47 %.
Key words: wood energy, energy statistics, unrecorded volumes, wood resources monitoring

1. INTRODUCTION

Bioenergy plays an important role in the energy mix of Germany. Moreover, with regard to energy security and climate change mitigation bioenergy is one of the key pillars for the transition of the energy system towards a more sustainable energy generation. Wood as a solid biomass provides a major share of bioenergy in Germany. Therefore it is obvious that all uses of wood for energy purposes should be recorded in energy statistics. It is necessary to report the development of bioenergy for e.g. market transparency and for a general knowledge about the different uses of wood.

However, the coverage of all woody and other solid biomass based energy in statistics is incomplete. Especially smaller sectors or smaller plants are not monitored by energy statistics in Germany. In case of wood energy these are namely the sectors of commercial and public services and of agriculture, forestry and fishing. But also companies of the manufacturing sector which employ less than twenty people are not covered by official statistics in Germany due to a general cut-off threshold. In this regard it is important to note that residential wood energy of private households is covered in energy statistics and hence not in the scope of our analysis.

Due to lack of information, various studies have been carried out in order to provide estimates on these unreported sectors or quantities in the last years. In addition to the mere estimation of the energy production some of these studies aimed to develop a methodology for a continuous data provision for renewable energy statistics (e.g. Schlomann et al., 2008; Viehmann et al., 2011, Rönsch et al., 2016). However, so far no realizable concept could be developed.

It is therefore the objective to outline a methodological concept to estimate the unreported quantities of wood energy. Based on this concept we firstly develop a time series for the period 2003 to 2014. Furthermore, the concept shall be also used to support future reporting of energy statistics by filling the gap of unmonitored sectors or plants.

The remainder of this paper is organized as follows. In subsequent chapter 2 the methodology approach will be outlined. In chapter 3 the results of the analysis are presented. Chapter 4 discusses the main findings and concludes the paper.

2. METHODOLOGICAL APPROACH

2.1. General Approach

Based on various empirical studies on the use of wood in firing plants we know for certain points in time the total use of woody biomass for energy generation. On the other hand, energy statistics do accurately record primary energy consumption in all relevant sectors except the commercial and public services sector, the agriculture, forestry and fishing sector and firing plants of companies of the manufacturing sector which employ less than twenty people. Hence, the basic methodological approach is striking simple: For a certain year, the difference between the empirically quantified wood energy consumption and the primary energy consumption of solid biomass in official energy statistics can be defined as the primary wood energy consumption of the commercial and public services sector, the agriculture, forestry and fishing sector and firing plants of companies of the manufacturing sector which employ less than twenty people. In the following these sectors and plants are named 'other commercial sectors'. The subsequent equation describes the general relation.

$$P \quad _{o} = PEC_{e} - P \quad _{o} \quad (1)$$

PEC – primary energy consumption (in Peta Joule PJ)
oc – other commercial sectors
es – empirical studies
os – official statistics

There are mainly two types of empirical studies. One type focuses on large-scale wood firing plants with a rated thermal input of at least one megawatt (MW), the other type focuses on small-scale wood firing plants with a rated thermal input below one megawatt. The studies on the large-scale wood firing plants were conducted as full surveys (Weimar and Mantau, 2006; Weimar, 2008; Weimar et al., 2012) whereas the studies on small-scale wood firing plants were compiled as sample surveys (Mantau, 2004; Musialczyk and Mantau, 2007; Mantau et al., 2012). Additionally, information on the use of wood in other firing plants which use wood for co-firing such as coal-fired plants or power plants in (e.g.) the cement industry were taken into account. The calculation of the total primary wood energy consumption of the empirical studies PEC_{es} is calculated as follows:

$$P \quad _{e} = P \quad _{s} + P \quad _{l} + P \quad _{o} \quad (2)$$

PEC – primary energy consumption (in PJ)
s – small-scale wood firing plants
l – large-scale wood firing plants
o – other firing plants

Data of the wood consumption for energy generation in wood firing plants is reflected in the empirical studies either in a dried stage (oven-dry metric tons, odmt) or on a wet basis ("as delivered" (UN, 2009)). The conversion from odmt to joule is done by using a conversion factor of 18.5 mega-joules (MJ) per kilogram. For the conversion of wet tons to odmt data on moisture content are provided by Weimar and Mantau (2006) and UN (2009). For the specific approach we aim to specify regression models. However, if this might not be possible for all cases we need to use linear interpolation between fixed points or extrapolation of empirical data.

2.2. Specific Approach

2.2.1. Small-scale wood firing plants

Small-scale wood firing plants are defined as plants with a rated thermal input below one megawatt (MW). For setting up a time series three data points from empirical studies are available for further analysis. The study of Mantau (2004) covers the year 2002. Musialczyk and Mantau (2007) refer to the year 2006 and Mantau et al. (2012) provide data for the year 2010. These studies have been conducted within the project wood resource monitoring. Based on these references we try to specify a regression model to find the line of best fit for the use of woody biomass in small-scale firing plants for the time period 2003 to 2014. To reflect the structure of this heterogeneous market we assume two major influences on the development.

One major share of small-scale wood firing plants is operated within the wood working and wood manufacturing companies. We assume that the use of wood for energy generation partly depends on the economic development of these firms as they are mainly using wood processing residues as fuels. To reflect this relation we use the economic development of annual turnover of the following sectors: manufacturer of products of wood (excluding wood-based panels) and manufacture of furniture. Data are provided by Becher (2015). For deflation of annual turnover we used the GDP deflator of the World Bank (2016). The other major share of small-scale wood firing plants is operated by different companies outside the wood-based industry such as the commercial and public services sector, the energy transformation sector or the agriculture, forestry and fishing sector. A main purpose of these plants is heat production for e.g. district heating. Studies show that the weather conditions during a heating period are relevant for the amount of wood used (e.g. Garbacz, 1985; Garbacz and Erickson, 1987; Schmoranz, 1994). Hence we assume that primary energy consumption for small plants is in addition to annual turnover of wood manufacturer also related to the heating demand of the heating period. We use annual heating degree days for further specification. Data are provided by Memmler (2016). The use of wood for energy generation of small-scale wood firing plants is calculated as follows:

$$U_{s,j} = \beta_0 + \beta_1 x_{1,j} + \beta_2 x_{2,j} + \varepsilon \quad (3)$$

U – use of wood for energy generation (in oven-dry metric tons (odmt))
s – small-scale firing plants
x_1 – annual turn over (in Euro, deflated)
x_2 – heating degree days (in Kelvin day, Kd)
j – year
β – parameters

We assume a linear correlation between the use of woody biomass and the explanatory variables. As so far only three data points for analysis are available the regression analysis could not be carried out fully due to the lack of degrees of freedom. Besides the estimation of the regression parameters and the coefficient of determination (R^2) no test statistics could be calculated (see table 1).

For this reason we decided to calculate the time series of the small-scale wood firing plants based on the development of sub-categories of the energy statistic. These sub-categories are assumed to reflect the development of the small plants. We defined the empirical studies as fixed points and used the development of the sub-categories for interpolation.

However, it is still the basic idea of the general methodological concept that we can specify a regression model if additional data are available. The next survey in this regard is already in the planning stage and will be carried out in 2017. Results are planned for late 2017, reference year will be 2016.

Table 1. Test statistics for small-scale wood firing plants

	Model (N = 3)	Variables	Coefficient estimates	Standard errors	t values	p values
R^2	1	β_0	-18888361	-	-	-
R^2 (adjusted)	-	β_1	0.27435	-	-	-
F-statistic	-	β_2	3321.16304	-	-	-
p value	-					

2.2.2. Large-scale wood firing plants

Large-scale firing plants are defined as plants with a rated thermal input of one megawatt or above. Basically, the approach applied for estimating the use of wood for energy production in large-scale firing plants is similar to the one applied for small-scale firing plants. Data on wood consumption are available for the years 2003, 2004, 2005 and 2011 provided by Weimar and Mantau (2006), Weimar (2008) and Weimar et al. (2012). These studies also have been conducted within the project wood resource monitoring. For our analysis we use additional annual statistics on the power and heat supply of solid biomass of the industry sector and the transformation sector provided by the working group on renewable energy statistics (AGEE-Stat).

We assume that the development of primary energy consumption of solid biomass reported in energy statistics reflects the development of large-scale wood firing plants. A regression analysis was carried out in order to calculate the best-fit line between the available empirical data for wood consumption in large-scale wood firing plants and the heat and power supply of industry and heating plants of energy statistics.

$$U_{l,j} = \beta_0 + \beta_1 x_{1,j} + \varepsilon \quad (4)$$

U – use of wood for energy generation (in oven-dry metric tons (odmt))
l – large-scale firing plants
x_1 – heat and power supply of industry and heating plants (in PJ)
j – year
β – parameters

We assume a linear correlation between the use of woody biomass and the explanatory variables. The explanatory variable x_1 is significant and shows the expected positive sign. Further test statistics are provided in table 2.

Table 2. Test statistics for large-scale wood firing plants

	Model (N = 4)	Variables	Coefficient estimates	Standard errors	t values	p values
R^2	0.9878	β_0	2690112	343216	7.84	0.0159
R^2 (adjusted)	0.9817	β_1	30.93702	2.42931	12.73	0.0061
F-statistic	162.18					
p value	0.0061					

2.2.3. Other firing plants: wood and non-woody solid biomass

In addition to the use of wood in small and large wood firing plants wood is also used for co-firing in e.g. in coal-fired power plants or in industrial power plants (e.g. cement industry). Wood which is burnt in incineration plants (mainly as waste) is not considered in this analysis. This part of energy generation is already recorded in statistics. Unfortunately, there is only very limited information on co-firing of wood in these other industrial plants. So far only one publication seems to refer to this issue (Mantau and Jochem, 2012). Based on this study we assume a constant wood consumption over time and we applied the quantity to the whole time period.

Information on non-woody solid biomass is also scarce. In empirical surveys about large-scale wood firing plants by Weimar and Mantau (2006) and Weimar et al. (2012) also plants were surveyed which only use non-woody solid biomass. However, the quantity was low compared to woody biomass. Hence we assume a constant quantity of non-woody biomass for whole time period.

If additional information on these uses solid biomass will be available, it will be taken into account and the assumptions will be modified.

3. RESULTS

Figure 1 shows the results of the calculation of the wood energy consumption from 2003 to 2014.

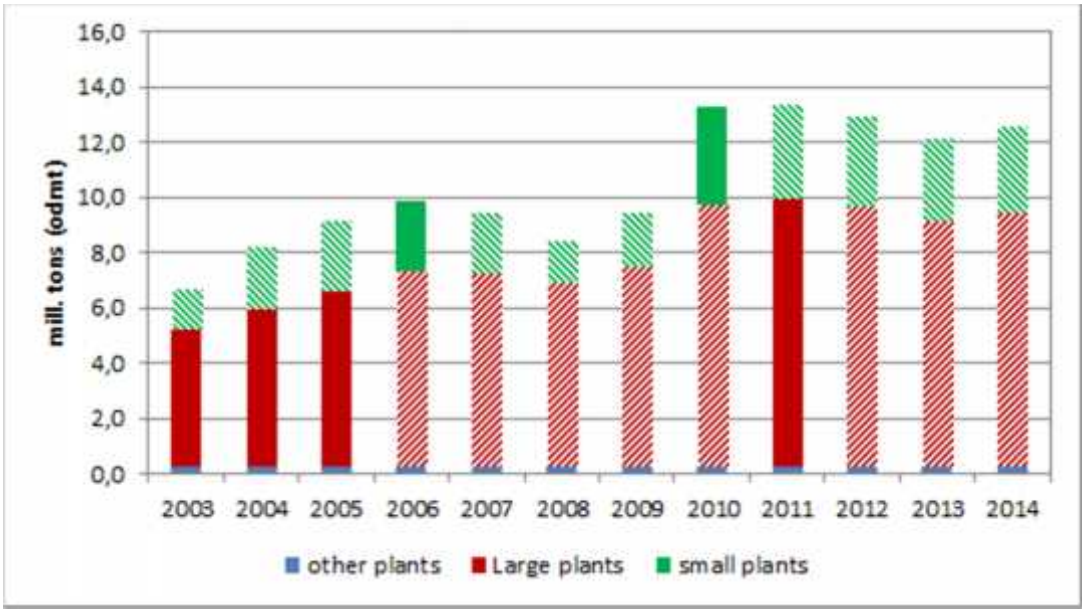


Figure 1. Estimated use of wood and other solid biomass for energy generation by sectors in Germany, in odmt

The figure presents the estimated time series of small-scale firing plants, large-scale firing plants and other firing plants. If available we used original data from empirical studies for a data point. Estimated data are shaded in figure 1. The huge increase in year 2010 is mainly due to changes in the statistical concept of the AGEE-Stat (2016) in this specific year. This significant increase can also be seen in the data of AGEE-Stat (2016) (for comparison please see figure 2). The total wood consumption for energy generation was about 6.6 million tons (odmt) in 2003 and constantly increased up to 9.9 million tons in 2006. A lower consumption level in the following years was followed by a significant increase up to 13.4 million tons in 2011. Recent years showed a slight decrease. The actual consumption in 2014 is estimated at 12.5 million tons.

Results for the estimation of the unmonitored other commercial sector (following formula 1) are shown in figure 2.

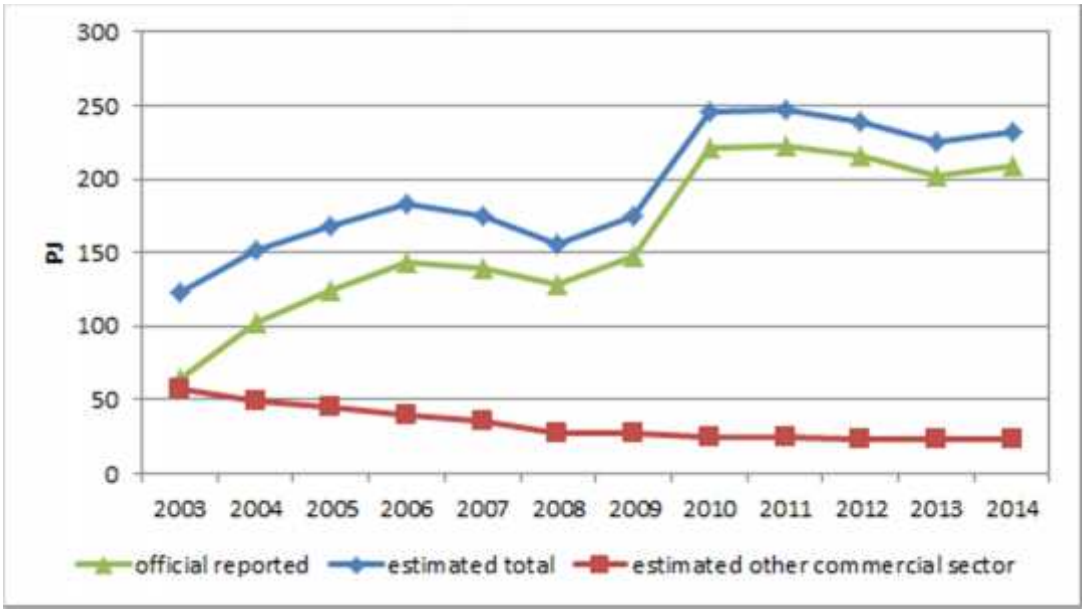


Figure 2. Time series of primary energy consumption of wood and other solid biomass in Germany, in PJ

The time series of other commercial sector shows a steady decline since 2003 to 2010. Since then the level remains more or less constant on a level of ca. 23 PJ. The starting point of our time series shows the highest level of primary energy consumption of the estimate of the other commercial sector (58 PJ). The actual level is about 23 PJ. The share of this sector on the total use of wood for energy production in Germany decreased from 47 % in 2003 to 10 % in 2014.

4. DISCUSSION AND CONCLUSION

The objective of this analysis was to develop a methodology for the estimation of the wood energy generation of sectors and plants which are not covered by official energy statistics. This was done by a comparison of empirical studies on the use of wood for energy generation and data from official energy statistics in Germany. The analysis showed results which are within the range of comparable studies (e.g. Merten et al., 2004; Schlomann et al., 2008; Viehmann et al. 2011). The methodological concept of this analysis proves to be suitable to support energy statistics in Germany. First results have been already applied to renewable energy statistics (AGEE-Stat, 2016).

Calculations were done using regression analysis to estimate best-fit-curves. However, not all parameters of the regression analyses could be statistically funded. This is due to only few data points for small-scale wood firing plants. Hence we also used linear interpolation for the estimation of this time series. Also information on non-wood solid biomass is scarce. This lack of data has to be improved if new empirical studies are available. It is the basic idea of the general methodological concept of the wood resource monitoring that regularly empirical surveys will be carried out which then shall improve the quality of the estimated data (Jochem et al., 2015). The next surveys on wood energy in firing plants are already planned and will be carried out in 2017. Hence, ex-post examinations in forthcoming periods will have a broader data basis.

Acknowledgements: The author would like to thank Michael Memmler, Frank Musiol and Thomas Nieder from the Working Group on Renewable Energy Statistics (AGEE-Stat) for their expert knowledge on energy statistics. Financial support by the project Wood Resource Monitoring (''Rohstoffmonitoring Holz'', project number FKZ 22021514) funded by the Federal Ministry of Food and Agriculture is gratefully acknowledged.

REFERENCES

1. AGEE-Stat, Arbeitsgruppe Erneuerbare Energie Statistik (Working Group on Renewable Energy Statistics) (2016): Zeitreihen zur Entwicklung der erneuerbaren Energien in Deutschland. Stand Februar 2016 (Time series on the development of Renewable Energy Sources in Germany. As of February 2016). http://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/zeitreihen-zur-entwicklung-der-erneuerbaren-energien-in-deutschland-1990-2015-excel.xlsx?__blob=publicationFile&v=6. Accessed 04.07.2016.
2. Becher, G. (2015): Clusterstatistik Forst und Holz: Tabellen für das Bundesgebiet und die Länder 2000 bis 2013. Hamburg: Johann Heinrich von Thünen-Institut, 109 p, Thünen Working Paper 48. DOI:10.3220/WP1443683579000.
3. Garbacz, C. (1985): Residential demand for fuelwood. Energy Econ 7: 191–193.
4. Garbacz, C.; Erickson, E. (1987): Residential demand for wood fuel. Resour Energy 9: 105–120.
5. Schmoranz, I. (1994): Die Energienachfrage privater Haushalte. Physica, Heidelberg. Wissenschaftliche Beiträge 95. ISBN 3-7908-0761-3.
6. Jochem, D.; Weimar, H.; Bösch, M.; Mantau, U.; Dieter, M. (2015): Estimation of wood removals and fellings in Germany: a calculation approach based on the amount of used roundwood. Eur J Forest Res 134 (5): 869-888, DOI:10.1007/s10342-015-0896-9.
7. Mantau, U. (2004): Holzrohstoffbilanz Deutschland - Bestandsaufnahme 2002. University of Hamburg, Centre of Wood Science and Technology, Department of Economics, Hamburg, 75p.
8. Mantau, U.; Jochem, D. (2012): Holzrohstoffmonitoring – Holzverwendung in Müllverbrennungsanlagen, Kohlekraftwerken und Zementwerken im Jahr 2010. University of Hamburg, Centre of Wood Science and Technology, Department of Economics, Hamburg, 23 p.
9. Mantau, U.; Möller, B.; Jochem, D. (2012): Holzrohstoffmonitoring - Die energetische Nutzung von Holz in Biomasseanlagen unter 1 MW im Jahr 2010. University of Hamburg, Centre of Wood Science and Technology, Department of Economics, Hamburg, 30p.
10. Merten, D.; Falkenberg, D.; Nill, M.; Kaltschmitt, M. (2004): Energieverbrauch des Sektors Gewerbe, Handel, Dienstleistungen (GHD), Anhang: Wärmegewinnung aus Biomasse. Leipzig 2004.
11. Musialczyk, C.; Mantau, U. (2007): Die energetische Nutzung von Holz in kommunalen und gewerblichen Kleinanlagen. University of Hamburg, Centre of Wood Science and Technology, Department of Economics, Hamburg, 46p.
12. Rönsch, C.; Sauer, P.; Bienert, K.; Schmidt-Baum, T.; Thrän, D. (2016): Biomasse zur Wärmeerzeugung – Methoden zur Quantifizierung des Brennstoffeinsatzes. DBFZ-Report Nr. 24, 137 p, DBFZ, Leipzig, Germany.
13. Schlomann, B.; Gruber, E.; Geiger, B.; Kleeberger, H.; Herzog, T.; Konopka, D-M. (2008): Energieverbrauch des Sektors Gewerbe, Handel, Dienstleistungen (GHD) für die Jahre 2004 bis 2006. Karlsruhe, München, Nürnberg 2008.
14. UN (2009): Forest Product Conversion Factors for the UNECE Region. United Nations, UNECE/FAO Timber Branch. Geneva Timber and Forest Discussion Paper 49. Geneva: UNECE.
15. Memmler, M. (2016): Gradtagszahlen (Heating Degree Days) 1999 to 2014. Calculated according to Ziesing, H.-J.; Diekmann, J. (1995): Energienachfrage in Deutschland in Abhängigkeit von Temperaturschwankungen und saisonalen Sondereffekten. Untersuchung im Auftrag des Bundesministers für Wirtschaft. Berlin, DIW.
16. Viehmann, C.; Westerkamp, T.; Schwenker, A.; Schenker, M.; Thrän, D.; Lenz, V.; Ebert, M. (2011): Ermittlung des Verbrauchs biogener Festbrennstoffe im Sektor Gewerbe, Handel, Dienstleistungen (GHD-Sektor). DBFZ-Report No 10, 197 p, DBFZ, Leipzig, Germany.

17. Weimar, H. (2008): Empirische Erhebungen im Holzrohstoffmarkt am Beispiel der neuen Sektoren Altholz und Großfeuerungsanlagen. Frankfurt a M; Berlin; Bern: Lang, 252 p, Hamburg, Univ, Diss, Sozialwiss Schr Forst Holzwirtsch 9.
18. Weimar, H.; Döring, P.; Mantau, U. (2012): Holzrohstoffmonitoring – Einsatz von Holz in Biomasse-Großfeuerungsanlagen 2011. University of Hamburg, Centre of Wood Science and Technology, Department of Economics, Hamburg, 27p.
19. Weimar, H.; Mantau, U. (2006): Standorte der Holzwirtschaft. Einsatz von Holz in Biomasse- und Holzfeuerungsanlagen. University of Hamburg, Centre of Wood Science and Technology, Department of Economics, Hamburg, 25p.
20. World Bank (2016): World Development Indicators, GDP deflator. As of 10th of August 2016.

Authors address:
Weimar, Holger*[1]
[1] Thünen Institute of International Forestry and Forest Economics, Hamburg, Germany
*Corresponding author: holger.weimar@thuenen.de

FINANCIAL ASPECTS OF FSC COC WOOD INDUSTRY CERTIFICATE HOLDERS

Klarić, K; Motik, D; Pirc Barčić, A

ABSTRACT

After the Earth summit held in Rio de Janeiro, the concept of sustainable development has been widespread across many industry sectors. In Croatian wood industry sector sustainable development initiative is mostly reflected in Chain of Custody (CoC) certification issued by the Forest Stewardship Council (FSC). Almost three hundred FSC CoC certificates are issued in Croatia today. The aim of this article is comparison of financial aspects of FSC CoC certified companies to financial aspects of wood industry sector in general.
Key words: wood industry, FSC CoC certification, financial aspects

1. SUSTAINABLE MANAGEMENT CERTIFICATION TRENDS IN WOOD INDUSTRY

1.1. World's certification trends

Today's global market is favourable to certified and environmentally appropriate products. Conducting business in such environment the wood industry companies can demonstrate environmentally responsible management by implementation of standards for chain of custody certification that is based on use of materials from responsibly managed forests (Bičanić et al., 2011). There are numerous organizations that promote sustainable management of world's forests and the two largest are Forest Stewardship Council® (FSC) and Programme for the Endorsement Forest Certification Schemes (PEFC). Both FSC and PEFC are non-governmental and non-profit organizations that are dedicated to promotion of responsible and sustainable forest management worldwide through independent third-party certification (FSC, 2016; PEFC, 2016). They promote environmentally appropriate, socially beneficial and economically viable principles in forest operations. Besides certification in forest management (FM) FSC and PEFC enable certification in wood industry, named chain of custody (CoC) certification. CoC certification is based on implementation of standards for tracking certified material from responsibly and sustainably managed forest to final product (FSCb, 2016; PEFCb, 2016). PEFC is the world's largest forest certification scheme, more than 300 million hectares of forest are certified under PEFC certification scheme (PEFC, 2016c). FSC is the world's second largest forest certification scheme under which 191 million hectares of forests are certified (FSC, 2016c). Regarding CoC certificates, 30 982 companies are the FSC CoC certificate holders (FSCc, 2016) and 10 909 companies are the PEFC CoC certificate holders (PEFC, 2015c). According to FAO (2015), certified forest area has grown from 18 million ha in 2000 to over 430 million ha in 2014, and it has increased by more than twenty times. Almost 90 % of global certificated area is on Northern Hemisphere (Fernholtz et al., 2015).

1.2. Croatian certification trends

All certificates for forest management are issued under FSC certification scheme in Croatia and as well as the majority of chain of custody certificates are issued by FSC (Bičanić et al., 2012). In Croatia 2 039 223 ha of forests are FSC certified from which 2 018 987 or 99 % is from Croatian State Forest enterprise (FSCd, 2016). Croatian State Forest enterprise manages state-owned forests that are FSC FM/CoC certified from 2002 and since then CoC certification of wood industry companies has started. Constant growth of the number of FSC CoC certificates is shown in Figure 1. The number of CoC certificates has quadrupled in the past ten years in Croatia. According to FSC Facts & Figures from the

August 2016 the number of issued FSC CoC certificates in Croatia is 262. Only four CoC certificates are issued in Croatia under the PEFC certification scheme (PEFCc, 2016).

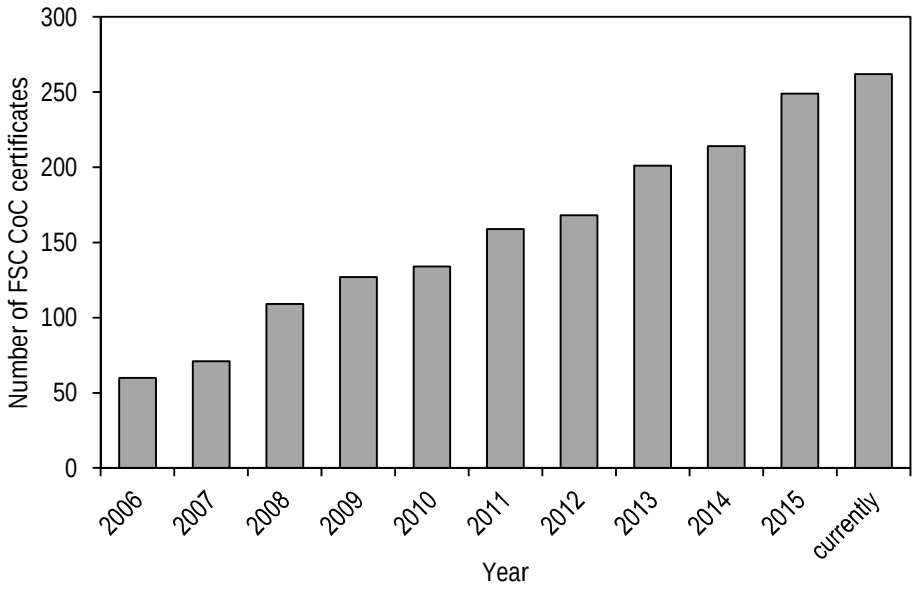


Figure 1. The number of FSC CoC certificates in Croatia

2. CROATIAN WOOD INDUSTRY PRODUCTS SALES

According to Croatian Bureau of Statistics, in 2014 the total value of industrial products sold by enterprises engaged in production of industrial products in the Republic of Croatia amounted to 121 343 million HRK (DZS, 2016). As compared to the previous year, the value of sold industrial products decreased by 1 701 million HRK, or by 1.4 %. According to the National Classification of Activities – NKD 2007 (N.N. nr. 58/07, 72/07) industrial sections, the value of sold industrial products in 2014 according to the product activity was the highest in section C Manufacturing, 102 743 million HRK, increasing to year 2013 by 6166 million HRK or by 0.61 %. More significant incensement in the value of sold industrial products had sectors manufacture of wood (11.43 %) and manufacture of furniture (29.13 %).

Table 1. Value of industrial products sold and export (Thousand HRK*).

Sector	2013				2014			
	Total value		Of that, abroad (export)		Total value		Of that, abroad (export)	
	HRK	%	HRK	%	HRK	%	HRK	%
Total – all sectors	123 043 991	100.00	46 572 291	100.00	121 343 138	100.00	50 125 074	100.00
C Manufacturing	102 113 426	82.99	46 350 084	99.52	102 743 046	84.67	43 473 049	86.73
C16 Manufacture of wood and of products wood	3 285 362	2.67	2 007 321	4.31	3 660 759	3.02	2 305 831	4.60
C31 Manufacture of furniture	2 686 551	2.18	1 781 229	3.82	3 469 250	2.86	2 513 775	5.02

*Midpoint Exchange Rates of Croatian National Bank for 2013 – 1 EUR = 7.573548 HRK and for 2014 – 1 EUR = 7.630014 HRK

Source: Croatian Bureau of Statistics, 2016.

Croatian wood processing and furniture manufacturing have been developed on high quality forest raw material, and their activities are based on the use of forest raw material, long wood-processing tradition and high quality of human resources (Pirc et al., 2010). Wood industry companies are mostly export oriented (Pirc et al., 2015), therefore it is very important to follow the foreign market trends (Table 1). Results conducted among Croatian FSC CoC certificate holders (Klarić et al., 2016) the most of them were certified on request of their customers, in order to keep customers they were obligated to implement certification. According to Kärnä et al. (2003) companies should seek competitive advantage through environmental friendliness and implementing environmental marketing voluntary. Since the trend of FSC certification has been widespread globally during last ten years, Croatian wood industry companies had to follow those trends in order to stay competitive. The aim of this article is comparison of financial aspects of Croatian FSC CoC certified companies to financial aspects of wood industry sector in general.

3. MATERIAL AND METHODS

In order to analyse financial performance of Croatian wood industry sector and companies that are holders of FSC chain of custody certificate in Croatia financial reports are gathered. The data for wood industry sector involved data obtained from Croatian Ministry of Finance and Financial Agency (FINA). Financial reports (income statement and balance sheet) needed for financial indicators calculation for FSC chain of custody certificate holders from Registry of financial reports (RGFI, 2015) were obtained. FSC Certificate Holder database (www.info.fsc.org) to collect data about FSC certificate holders was used.

For comparison of companies from wood industry sector with and companies that are FSC chain of custody certificate holders following financial indicators are used:

- Return on Assets – ROA;
- Return on Equity – ROE;
- Return on Sales – ROS.

Besides mentioned data Earnings before interest and taxes; Efficiency of total equity; Total income; Total expenses; Profit per employee; Total income per employee were analysed.

4. RESULTS

In Table 2 certified product groups by FSC product classification of Croatian wood industry companies are presented (FSC-STD-40-004a V2-1, 2013). As seen in Table 2 the largest number of chain of custody FSC certificate holders are certified for sawn wood (W3 = 69.54 %). The number of FSC certified companies decrease by increasing product finalization level and/or wood products added value. Hence, only 19.21 % of FSC CoC certificate holders are certified for indoor furniture (W12).

Table 2. FSC certified products among Croatian FSC certificate holders

FSC product groups	Number of certified companies	Percent of certified companies
W1 – Rough wood	204	67.55 %
W2 – Wood charcoal	1	0.33 %
W3 – Wood in chips or particles	194	64.24 %
W4 – Impregnated / treated wood	8	2.65 %
W5 – Sawn wood (sawn, chipped, sliced or peeled)	210	69.54 %
W6 – Products from planning mill	35	11.59 %

FSC product groups	Number of certified companies	Percent of certified companies
W7 – Veneer	54	17.88 %
W8 – Wood panels	27	8.94 %
W9 – Engineered wood products	66	21.85 %
W10 – Wood package	36	11.92 %
W11 – Wood for construction	99	32.78 %
W12 – Indoor furniture	58	19.21 %
W13 – Outdoor furniture and gardening	30	9.93 %
W14 – Musical instruments	1	0.33 %
W15 – Recreational goods	5	1.66 %
W16 – Household articles	11	3.64 %
W17 – Stationery of wood	1	0.33 %
W18 – Other manufactured wood products	7	2.32 %
W19 – Other wood products n.e.c.	8	2.65 %

* this table is continuation of Table 2 from previous page

The financial aspects of FSC CoC certificate holders in Croatia are shown in Table 3. The average earnings before interest and taxes of wood industry FSC CoC certificate holders in 2013 was 1 712 082 HRK and in 2014 was 1 725 080 HRK. Lower average total income compared to previous year was in 2014, earnings before taxes compared to previous year increased by 0.76 %. Financial indicators Return on Assets; Return on Sales; Return on Equity were positive for both analysed years. Almost 90 % of companies with implemented FSC certification ended 2013 and 2014 with profit.

Table 3. Croatian FSC wood industry certificate holder's financial indicators values

Financial indicators	Aritmetic Mean	Standard Deviation	Q1	Median	Q3
EBIT 2013 (HRK*)	1 712 082	2 984 550	8 775	348 319	1 723 174
EBIT 2014 (HRK)	1 725 080	4 261 600	28 709	356 971	3 503 385
ETE 2013 (%)	102.52	14.35	100.70	102.80	105.95
ETE 2014 (%)	102.71	9.48	100.40	101.80	106.58
ROA 2013 (%)	7.33	12.32	0.85	4.50	8.80
ROA 2014 (%)	3.97	10.01	0.63	3.10	7.73
ROE 2013 (%)	24.49	30.40	4.40	16.15	43.58
ROE 2014 (%)	15.41	29.08	3.75	11.90	24.65
ROS 2013 (%)	3.13	6.28	0.65	2.30	4.55
ROS 2014 (%)	1.28	9.34	0.40	1.45	5.05
TI 2013 (HRK)	54 461 782	82 780 693	3 474 231	27 047 846	56 720 298
TI 2014 (HRK)	53 857 211	73 615 045	5 392 283	26 859 678	69 897 640
TE 2013 (HRK)	52 846 318	81 950 243	3 777 557	26 065 970	56 389 143
TE 2014 (HRK)	52 530 611	72 195 234	5 324 566	25 710 448	64 643 067
PPE 2013 (HRK)	47 775	121 991	1 971	9 177	30 052
PPE 2014 (HRK)	47 245	162 745	605	7 207	37 123
TIPE 2013 (HRK)	1 418 124	2 459 911	251 865	436 646	1 647 894
TIPE 2014 (HRK)	1 542 775	2 808 060	264 988	461 460	1 305 462

Legend: EBIT - earnings before interest and taxes; ETE – efficiency of total equity; ROA – return on assets; ROE – return on equity; ROS – return on sales; TI – total income; TE – total expenses; PPE – profit per employee; TIPE – total income per employee

*Midpoint Exchange Rates of Croatian National Bank for 2013 – 1 EUR = 7.573548 HRK and for 2014 – 1 EUR = 7.630014 HRK

Comparisons of profitability ratios between wood industry sector and companies that are FSC CoC certificate holders in Figure 2 are presented. In 2013 and in 2014 profitability ratios Return on Sales and Return on Equity were higher for those companies that hold FSC chain of custody certificate. In 2014 wood industry sector had higher Return on Sales than FSC CoC companies, while in 2013 the situation was opposite. In general, according to given profitability ratios companies that are FSC certificate holders comparing to companies from wood industry sector had higher ratios of almost all profitability indicators, that may led to assumption that those companies had better financial performance.

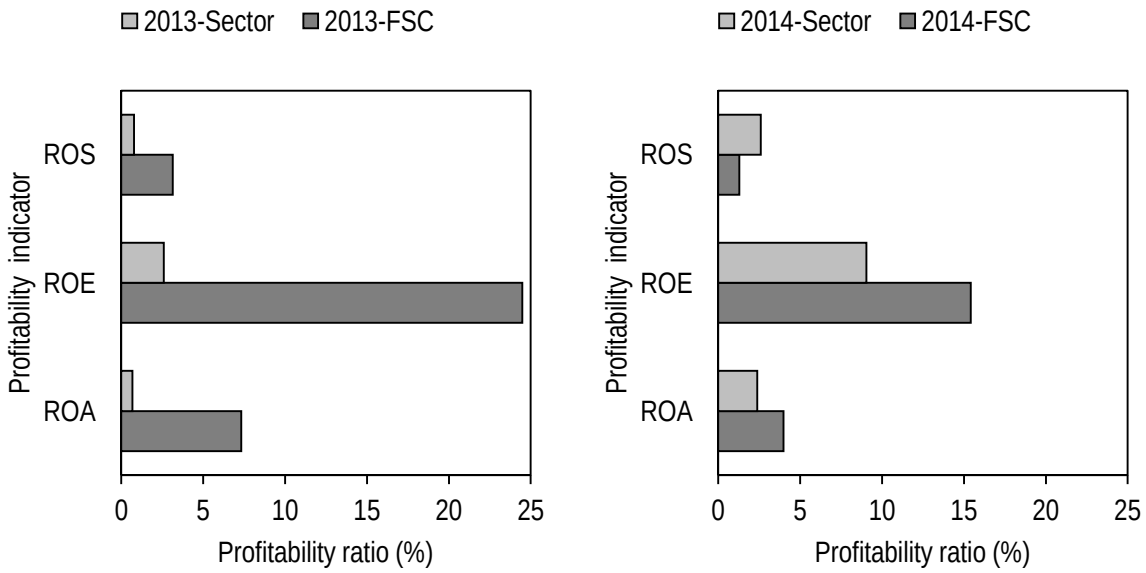


Figure 2. Profitability indicators of wood industry sector (SECTOR) and FSC CoC certificate holders (FSC)

5. CONCLUSION

Croatian wood industry is very important part of manufacturing sector, it employs large portions of workers in rural areas, it is export oriented and therefore its development is very important for Croatian economy. The results of this research indicate the positive trend in wood industry companies, with the slightly better results of companies that are FSC chain of custody certificate holders. Therefore, it is necessary to proceed with positive trends, implement the strategy of wood industry that will support the development of production of higher added valued products.

The future of wood industry lays on global trends of sustainable management, economic viability should be achieved taking into account environmental and social needs of all interested parties. Environmental awareness of today's customers is rising, therefore is very important to follow those trends in order to stay competitive, and one of the directions for wood industry is to implement standards of chain of custody that certifies products originating from responsibly managed forests. Although the certification in Croatia is voluntary, the wood industry companies should be prepared for present and for the future customers' requirements and desires. The availability of certified raw material enables wood industry companies to be forerunners of sustainable development and to achieve competitive advantage on turbulent market.

REFERENCES

1. Bičanić, K.; Klarić, M.; Greger, K., (2011): Ispunjavanje zahtjeva tržišta Europske Unije implementacijom FSC standarda. Drvo je prvo - izazovi sektora pred ulaskom u EU, Ivica Grbac (ur.). Sveučilište u Zagrebu, Šumarski fakultet, Zagreb, 21.10.2011., pp. 17-27.
2. Bičanić, K.; Greger, K.; Grladinović, T.; Perić, I.; Ćošić, V. (2012): Certification documentation for responsible forest management in practice. WOODema 2012 - Wood and Furniture Industry in Times of Change – New Trends and Challenges, Rybanský, R; Nováková, R. (ur.). Faculty of Mass Media Communication UCM in Trnava, Slovačka, 6.-8.6.2012., pp. 8-14
3. Fernholz, K.; Kraxner, F.; Novoselov, I.; Oliver, R.; Tissari, J. (2015): Policies shaping forest products markets. Forest products annual market review 2014-2015 (No. 39). United Nations Economic Commission for Europe/ Food and Agriculture Organization of the United Nations, Forestry and Timber Section, Geneva, Switzerland.
4. Kärnä, J.; Hansen, E.; Juslin, H. (2003): Social responsibility in environmental marketing planning', European Journal of Marketing, 37(5/6), pp. 848–871. doi: 10.1108/03090560310465170.
5. Klarić, K.; Greger, K.; Klarić, M.; Andrić; T.; Hitka, Miloš.; Kropivšek, J. (2016): An Exploratory Assessment of Chain of Custody Certification Benefits in Croatian Wood Industry. Drvna industrija, 67(3) – accepted for publication.
6. Pirc, A.; Motik, D.; Moro, M.; Posavec, S.; Kopljar, A. (2010): Analiza pokazatelja stanja na tržištu drvnih proizvoda Republike Hrvatske. Drvna industrija, 61(4), 229-238.
7. Pirc, A.; Liker, B.; Motik, D.; Moro, M. (2015): Financial analysis of Croatian furniture industry. 26th International Conference on Wood Science and Technology (ICWST): Implementation of Wood Science in Woodworking Sector / Grbac, I.; assistants to Editor-in-chief: Živković, V.; Miklečić, J.(ur.). Zagreb: University of Zagreb, Faculty of forestry, 2015. pp. 127-134
8. DZS (2016): Industrial production in 2014, Annual PRODCOM Results, Croatian Bureau of Statistics, October 2015, ISSN 1330-0350
9. Nacionalna klasifikacija djelatnosti 2007. – NKD 2007. Narodne novine, 58/07 i 72/07.
10. ****FAO, 2015: Global Forest Resources Assessment 2015: How have the world's forests changed? Food and Agriculture Organization of the United Nations. ISBN 978-92-5-108821-0, Rome, Italy.
11. ***FSCa (2016): About us: Who we are
URL: https://ic.fsc.org/en/about-fsc
12. ***FSCb (2016): Types of FSC certificates
URL: https://ic.fsc.org/en/about-fsc
13. ***FSCc (2016): FSC Facts & Figures; August 4, 2016
URL: https://ic.fsc.org/preview.facts-figures-august-2016.a-6110.pdf
14. ***FSCd (2016): Public certificate search
URL: http://info.fsc.org/certificate.php
15. ***FSC-STD-40-004a V2-0, 2011: FSC Product Classification, Forest Stewardship Council.
URL: http://www.info.fsc.org
16. ***PEFCa (2016): About PEFC: Who we are
URL: http://www.pefc.org/about-pefc/who-we-are
17. ***PEFCb (2016): Chain of Custody certification
URL: http://www.pefc.org/certification-services/supply-chain
18. ***PEFCc (2016): PEFC Global Statistics: SFM & CoC Certification, June 2016
URL: http://www.pefc.org/images/documents/PEFC Global Certificates - June 2016.pdf
19. ***RGFI, 2015: Registar godišnjih financijskih izvještaja, Financijska agencija – FINA
URL: http://www.rgfi.fina.hr

Authors address:
Klarić, Kristina[1]; Motik, Darko*[1]; Pirc Barčić, Andreja[1]
[1] Department for Production Organization, Faculty of Forestry, University of Zagreb, Zagreb, Republic of Croatia
*Corresponding author: motik@sumfak.hr

THE EFFECTIVENESS OF SELECTED MACHINERY AND EQUIPMENT IN THE WOODWORKING JOINERY

Stasiak-Betlejewska, R.; Ulewicz, R.

ABSTRACT

The effectiveness of machinery and equipment is one of the most important determinant of the product quality in the woodworking joinery. The appropriate conditions of the machines working have the influence on the production performance. A paper presents research findings on the machines effectiveness with applying PAMCO indicators.

Key words: woodworking industry, the production output, PAMCO indicators

1. INTRODUCTION

One of the most important conditions for the success of the contemporary production enterprises is ensuring timely supply of products characterized by the quantity and quality in accordance with the customer's specification [Bičanić et all 2009]. Achieving this goal requires the company to guarantee the reliability of the productive apparatus, or full control of the technical condition of machinery, equipment and facilities. This activity is carried out in the framework of maintenance or the daily, systematic work related to the implementation of planned one-time or periodic tasks in order to prevent degradation in the quality of the equipment and the failure occurrence or applying measures to restore the production of the production equipment full functionality [Pirc - Barčić et all 2016].

Developing dynamically discipline of knowledge concerning the machines and technical equipment operation is being built on a basis of the maintenance science that includes: main operating systems, reliability, tribology, diagnostics, technical, safety of machinery [Ożadowicz, 2007]. The assessment of the complex systems operation performance uses the following properties [Bryke, 2005]:

- efficiency - identified as the effective use of resources at a given time on intended purpose,
- readiness - expressing possibility of action operated facilities, including the system as a whole, at a given moment of a time,
- performance - synonymous with the intensity of tasks,
- effectiveness - achieving status highlighted as a positive set of possible status,
- efficiency - the possibility of finding the system in the conditions specified by the host system,
- cost-effectiveness - ownership expresses the relationship between the achieved results and the size of the expenditures incurred in a certain period of time,
- Reliability - the property of expressing the degree of trust that is met the required action.

The volume of the production depends on the machinery, its technical condition and directs the performance and then these factors have played a significant role in the approach to the machinery in an analyzed manufacturing company. A system for monitoring the machine park status is becoming more popular nowadays. As a result, it is possible to predict and prevent technical faults [Dwiliński 2006]. Currently a strategy of the equipment maintenance is applied along TPM technical machine status (Total Productive Maintenance), whose objective is to achieve ZERO defects in machines maintenance, ZERO defects in the production and ZERO accidents at the work stations. This concept of the excellence is connected with the enterprise assets management, which allows productivity increasing, the product quality improving and the profitability expanding [Chabiera et all 2000].

The aim of this study is to analyze the machinery efficiency in the construction industry enterprise. The study verified a thesis according to which the prevention and maintenance of the machines in the enterprise is one of the basic objectives raising the productivity and the quality level.

2. THE RESEARCH METHODOLOGY

Assessment of the material resources use (Plant & Machine Control - PAMCO) was applied in 1976 as the common language defining corporate and machinery results allowing the use of uniform criteria for comparing companies with similar profile and a similar machine park. In 1990 PAMCO definitions have been simplified and standardized for all companies so that their results could be easily and quickly compare [Bryke 2005].

The PAMCO methodology shows parameters of the measurement and reporting work of technical objects, defines the machine working time to analyze the machines operation and processes, reduces the number of previously used parameters, provides the basis of measurement of these devices, which can be modified. Time, according to PAMCO has been divided into types, which are calculated according to its individual indicators, giving a full and clear picture of the machine use and the performance of the company.

Table 1. The PAMCO times indicators structure

<table>
<tr><td colspan="6">Total Time TT = 168 h</td></tr>
<tr><td colspan="5">Available Time AT = TT - UAT</td><td>Unavailable Time UAT</td></tr>
<tr><td colspan="4">Used Time UT = AT - UAT</td><td>Available Unused Time AUT</td><td>Due to national or religious holidays, Saturdays, Sundays</td></tr>
<tr><td colspan="3">Operation Time OT = UT - PNOT</td><td>Planned Inoperable Time PNOT</td><td>Due to the line stops due to a lack of orders, autonomous maintenance</td><td></td></tr>
<tr><td colspan="2">Production Time PT = OT - rps</td><td>Routine production stops rps</td><td>Due to a change of plans, technologists attempts, renovations</td><td></td><td></td></tr>
<tr><td rowspan="2">Effective Time ET = PT - us</td><td>Unplanned Stops us</td><td>Due to the clearing, products change, stops and loss of production, routine alterations to the machine</td><td></td><td></td><td></td></tr>
<tr><td>Due to the small stops, failures, regulations, errors, technological problems, disruption of logistics</td><td></td><td></td><td></td><td></td></tr>
</table>

Time indicators presented in Table 1 were used to calculate the PAMCO times indicators, aimed at the machines efficiency measurement. The method PAMCO is applied to calculate the following indicators [Bryke, 2005]:

- Production Efficiency (PE) - indicator of production efficiency

$$PE = \frac{ET}{PT} \times 100\%$$

where:
ET - Effective time - actual time at which the machine produced products
PT - Production Time

- Operational Efficiency (OE) - indicator of operational efficiency

$$OE = \frac{ET}{OT} \times 100\%$$

where:
ET - Effective time - actual time at which the machine produced products
OT - Operation Time

- Available Utilization (AU) - indicator of the used available time

$$AU = \frac{OT}{AT} \times 100\%$$

where:
OT – Operation Time
AT – Available Time – possible to use the time in which the machine can operate

- Asset Availability (AA) – indicator of the total time availability

$$AA = \frac{AT}{TT} \times 100\%$$

where:
TT – Total Time – the total length of a given research time (i.e. 168 h, 365 days)
AT – Available Time – possible to use the time in which the machine can operate

- Asset Utilization (AUt) - indicator of used total time

$$AUt = \frac{UT}{TT} \times 100\%$$

where:
TT – Total Time – the total length of a given research time (i.e. 168 h/week, 365 days/year)
UT – Used Time

- Operational Utilization (OU) - wskaźnik sprawności czasu całkowitego

$$OU = \frac{OT}{TT} \times 100\%$$

where:
TT – Total Time – the total length of a given research time (i.e. 168 h/week, 365 days/year)
OT – Operation Time

- Production Utilization (PU) - indicator of total production time

$$PU = \frac{PT}{TT} \times 100\%$$

where:
TT – Total Time – the total length of a given research time (i.e. 168 h/week, 365 days/year)
PT – Production Time

- Effective Utilization (EU) - indicator of actual total used total

$$EU = \frac{ET}{TT} \times 100\%$$

where:
TT – Total Time – the total length of a given research time (i.e. 168 h/week, 365 days/year)
ET - Effective time - actual time at which the machine produced products

Presented indicators enable to settle the enterprise with their tasks in the field of the production and its results compared with other companies and can assist in making decisions about necessary activities and the enterprise development.

3. RESEARCH FINDINGS AND DISCUSSION

There is the effective preventive nature of the machines and equipment maintenance in the analyzed enterprise. The procedure in this regard regulates manual oversight infrastructure. The purpose of this manual is to establish procedures for conducting, recording, surveillance and preventive work - repairs, maintenance and emergency of the individual machines and equipment, and tools that are supplied to the plant. Responsibility for ensuring the safe condition of the equipment and devices through supervision inspections and repairs carried out by the subordinate services belong to the Technical Director and the implementation of individual measures within the framework of the maintenance is the responsibility of the General Mechanic and General Electric's. In particular, their duties include:

– conducting a prevention and surveillance used in various processes, machines, equipment and tools,
– quality and timely execution of preventive maintenance of machinery and equipment,
– carrying out inspection, maintenance of machines and equipment in a documented manner,
– organization of ergonomic workplaces of subordinated personnel while performing preventive and breakdown.

As the part of the infrastructure supervision procedure, the entire equipment and tools that equip the departments are subject to recording in a document that contains information about the name of the machine/device, serial number, type, date of entry and withdrawal from the use. The purchase of the new or the withdrawal with the use of machinery equipment and tools, a recording of this fact in the mentioned document is mandatory. The General Mechanic in cooperation with the General Electrician draw up and update the machine/device card that contains the name and number of the device and specifying in detail the workflow associated with the review and maintenance of the machine/device and its frequency. There are registered all the repair of the machine/device in this document.

In the analyzed enterprise the issue of maintenance and the machinery use are mainly based on prevention. In the second half of 2015, a noted number of failures reached 19 cases and a period of equipment incapacity because of this reached only 123 hours. The aggregated weekly times of the work machines inability due to its failure do not exceed 20 hours in the second half of 2015. Such a low time dimension failure is caused by two elements of the preventive maintenance of machines and devices:

– autonomous maintenance machinery and equipment,
– planned repairs and maintenance.

Inspection and maintenance for each machine have been planned on a quarterly or semi-annual frequency. Fund of planned repairs, inspections, maintenance didn't exceed 40 hours per week in the analyzed half of 2015, which constitutes less than a half of the nominal general fund percent for machines operating per each week (Figure 1).

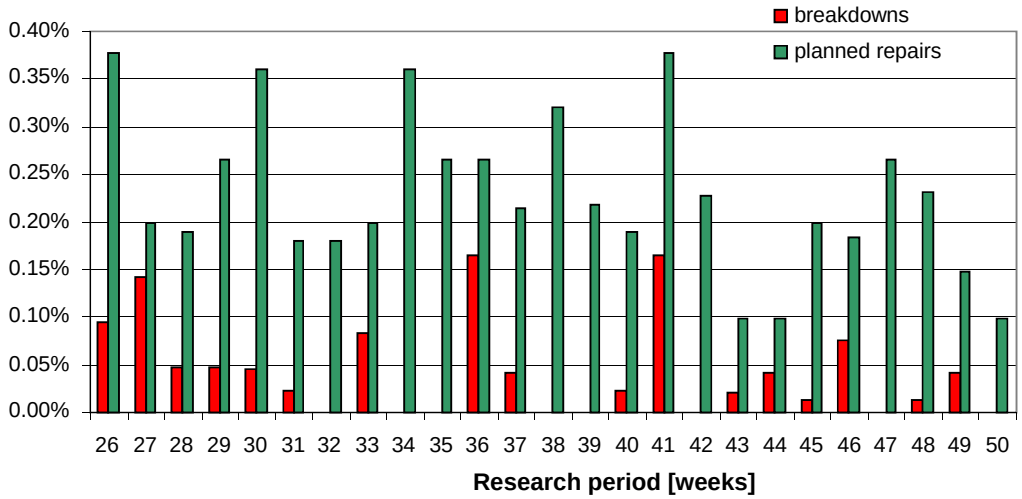


Figure. 1. The dynamics of the machine downtimes structure in the analyzed company X in 2015.

The low number and time of the failure and the downtime time planned due to repairs, maintenance and inspections are the result of a significant amount of an autonomous maintenance time. The operator of each machine at each shift makes the preventive machine maintenance in 15 -30 min for the emergency machine maintenance. Each of the machine in the analyzed enterprise is subjected to the machine operation analysis due to its efficiency.

Table 2 presents the observed PAMCO times indicators for the multihead milling machine Griggio from June 2015 to mid-December 2015, while Table 3 presents calculated PAMCO times indicators for the device in the analyzed period.

Analyzing collected times indicators, it can be noted that the total time per week (168h), the minimum effective time during the analyzed period was only 113.5 h (in 35th week). The maximum effective time reached the highest number (153 h in 28th week). Average effective time in the analyzed enterprise amounted to 143 h, which represents almost 84% of the total time. Analyzing the research results, it can be noted that in the analyzed period the average indicator of the production efficiency (PE) amounted to 98.5%, while the indicator of effective utilization (EU) - only 84% (Table 3).

Analyzing the set of PAMCO indicators listed in Table 3, it can be noted that there are significant disparities between different indicators, as well as between the same indicators for different periods. The maximum dispersion for the EU indicator was 24%, as similar to PU and OU indicators, which indicate irregularities in the machine use times. It is worth noting that the lowest efficiency operation time was recorded in the 37th week (EU = 67.6%). Mainly it was related to the lack of the production order for this machine (in 32 h) and the correction settings (5 h). In turn, the highest indicator of the total production time use (PU) was recorded in eight weeks (30, 32, 33, 38, 41, 44, 49, 50), when it was up to 96.67%. In turn, the effective use of the total time reached a maximum at 96.67%, wherein, the value reached in only 4 weeks, i.e. 30, 41, 44 and 49th week.

Table 1. The research results on the multihead milling machine X_1 availability times observations

The research period (a number of the week)	Total Time TT	Unavailable Time UAT	Available Time AT	Available Unused Time AUT	Used Time UT	Planned Inoperable Time PNOT	Operation Time OT	Routine production stops rps	Production Time PT	Unplanned stops us	Effective Time ET
26	168	4	164	10.5	153.5	0	153.5	3.5	150	1	149
27	168	24	144	10.5	133.5	0	133.5	3.5	130	3	127
28	168	0	168	10.5	157.5	0	157.5	3.5	154	0	154
29	168	32	136	10.5	125.5	1	124.5	3.5	121	1	120
30	168	0	168	10.5	157.5	0	157.5	3.5	154	2	152
31	168	0	168	10.5	157.5	0	157.5	3.5	154	0.5	153.5
32	168	8	160	10.5	149.5	0	149.5	3.5	146	0	146
33	168	24	144	10.5	133.5	0	133.5	3.5	130	0	130
34	168	0	168	10.5	157.5	2	155.5	3.5	152	0	152
35	168	40	128	10.5	117.5	0,5	117	3.5	113.5	0	113.5
36	168	0	168	10.5	157.5	0	157.5	3.5	154	4	150
37	168	32	136	10.5	125.5	0	125.5	3.5	122	5	117
38	168	24	144	10.5	133.5	0	133.5	3.5	130	0	130
39	168	0	168	10.5	157.5	0	157.5	3.5	154	0	154
40	168	0	168	10.5	157.5	1	156.5	3.5	153	0.5	152.5
41	168	24	144	10.5	133.5	0	133.5	3.5	130	0.5	129.5
42	168	0	168	10.5	157.5	0	157.5	3.5	154	0	154
43	168	0	168	10.5	157.5	0,5	157	3.5	153.5	0.5	153
44	168	0	168	10.5	157.5	0	157.5	3.5	154	25	129
45	168	8	160	10.5	149.5	0	149.5	3.5	146	5	141
46	168	24	144	10.5	133.5	0	133.5	3.5	130	3	127
47	168	0	168	10.5	157.5	0	157.5	3.5	154	0	154
48	168	0	168	10.5	157.5	0	157.5	3.5	154	2	152
49	168	8	160	10.5	149.5	0	149.5	3.5	146	1	145
50	168	16	152	10.5	141.5	0	141.5	3.5	138	0	138
Average	168	10.72	157.28	10.5	146.78	0.2	146.58	3.5	143.08	2.16	140.92

Analysis of the PAMCO individual indicators, there declines of the machine working time use were noted. They take quite irregular appearance periodicity. A worrying phenomenon is the irregularity of the process and its explosive nature. It is therefore necessary to implement a better organization of the machine working time. It allows planning the scale and timeliness of production on the analyzed machine. Besides, at present there are significant losses arising from inefficient (far from the nominal one) use of the machine working time. Depth analysis of PAMCO times indicators and minimize downtimes, both planned and unplanned, is required.

Table 3. The PAMCO times indicators for the multihead milling machine X_1

The reserach period (week: 28/2015 – 52/2015)	Indicator of the production efficiency PE	Operationbal Efficiency OE	Available Utilization AU	Asset Availibity AA	Asset Utilization AUt	Operational Utilization OU	Production Utilization PU	Effective Utilization EU
28	99.33	97.07	93.60	97.62	91.37	91.37	89.29	88.69
29	97.69	95.13	92.71	85.71	79.46	79.46	77.38	75.60
30	100.00	97.78	93.75	100.00	93.75	93.75	91.67	91.67
31	99.17	96.39	91.54	80.95	74.70	74.11	72.02	71.43
32	98.70	96.51	93.75	100.00	93.75	93.75	91.67	90.48
33	99.68	97.46	93.75	100.00	93.75	93.75	91.67	91.37
34	100.00	97.66	93.44	95.24	88.99	88.99	86.90	86.90
35	100.00	97.38	92.71	85.71	79.46	79.46	77.38	77.38
36	100.00	97.75	92.56	100.00	93.75	92.56	90.48	90.48
37	100.00	97.01	91.41	76.19	69.94	69.64	67.56	67.56
38	97.40	95.24	93.75	100.00	93.75	93.75	91.67	89.29
39	95.90	93.23	92.28	80.95	74.70	74.70	72.62	69.64
40	100.00	97.38	92.71	85.71	79.46	79.46	77.38	77.38
41	100.00	97.78	93.75	100.00	93.75	93.75	91.67	91.67
42	99.67	97.44	93.15	100.00	93.75	93.15	91.07	90.77
43	99.62	97.00	92.71	85.71	79.46	79.46	77.38	77.08
44	100.00	97.78	93.75	100.00	93.75	93.75	91.67	91.67
45	99.67	97.45	93.45	100.00	93.75	93.45	91.37	91.07
46	83.77	81.90	93.75	100.00	93.75	93.75	91.67	76.79
47	96.58	94.31	93.44	95.24	88.99	88.99	86.90	83.93
48	97.69	95.13	92.71	85.71	79.46	79.46	77.38	75.60
49	100.00	97.78	93.75	100.00	93.75	93.75	91.67	91.67
50	98.70	96.51	93.75	100.00	93.75	93.75	91.67	90.48
51	99.32	96.99	93.44	95,24	88.99	88.99	86.90	86.31
52	100.00	97.53	93.09	90.48	84.23	84.23	82.14	82.14
Average	98.52	96.14	93.15	93.62	87.37	87.25	85.17	83.88

4. CONCLUSION

A particular aspect of the management system development in the enterprise is implemented machinery and equipment maintenance policy, which is supported by introduced the infrastructure supervision, elements of the study the machinery and equipment efficiency and examination of the machines quality. The machine utilization in the analyzed enterprise is registered, and any inapropriate case different from the correct machine operation is even eliminated on the basis of the determination and implementation of preventive measures, especially in the field of autonomous maintenance.
In the analyzed company the effective preventive nature of the machinery and equipment maintenance is obligated. The procedure to be followed in this field is governed by the guidelines of the infrastructure supervision whose the aim is establishin procedures for realization, accounting, supervision and preventive, maintenance and emergency works on the individual machines, equipment and tools which supplied the plant. It enables the analyzed enterprise to reduce the number and the failures duration

time to a minimum time (less than 0.5% of the nominal fund of machines), and the number of planned shutdowns due to planned maintenance has been minimized to a level of 0.5% of the nominal fund of machines.

REFERENCES

26. Bičanić, K., Jelačić, D., Gasparic, V., Carev-Laskarin, V., Kocbek-Nizetic, M. (2009): Corporate identity in wood processing and furniture manufacturing in the Republic of Croatia, DRVNA INDUSTRIJA, Vol. 60, Issue 3, pp. 145-153.
27. Bryke, M. (2005): Wstęp do Kaizen - Efektywność warunkiem przetrwania - skuteczne metody zwiększania produktywności przedsiębiorstw, Kraków
28. Chabiera, J.; Doroszewicz S.; Zbierzchowska, A. (2000): Zarządzanie jakością. Poradnik menedżera, Centrum Informacji Menedżera CIM, Warszawa
29. Dwiliński, L. (2006): Podstawy eksploatacji obiektu technicznego, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa
30. Gejdoš, M.; Potkany, M. (2015): Development of market with wood in Slovakia and Central Europe, Wood Processing and Furniture Manufacturing Challenges on the World Market, Proceedings of Scientific Papers Wood-Based Energy Goes Global, Dubrovnik, Croatia
31. Ożadowicz, A. (2007): OEE w praktyce zakładowej, Utrzymanie ruchu
32. Pirc - Barčić, A., Motik, D., Oblak, L., Vlosky, R. (2016): Management Activity Linkages to Innovation Deconstruction: An Exploratory Study of the Furniture Industry in Croatia, BIORESOURCES, Vol. 11, Issue 2, pp.: 3987-4005
33. Ulewicz, R.; Jelonek, D.; Mazur, M. (2016): Implementation of logic flow in planning and production control, Management and Production Engineering Review 7 (1), pp. 89-94.

Authors address:
Stasiak-Betlejewska, Renata*[1]; Ulewicz, Robert[2]
[1] Institute of Production Engineering, Faculty of Management, Częstochowa University of Technology, Poland
[2] Institute of Production Engineering, Faculty of Management, Częstochowa University of Technology, Poland
*Corresponding author: renatastasiak@wp.pl

WOOD LOG HOUSE – COMPREHENSIVE THERMAL PREDICTION AND ENERGY CONSUMPTION QUANTIFICATION

Búryová, D.; Sedlák, P.

ABSTRACT

This paper focuses on log house properties that are affecting its heating energy consumption, with connection to state-of-the art knowledge and current experiments and research. Evaluation is based on results of comparison from experiments and from calculations and simulation. The on-site multipurpose monitoring was performed on a built log house. There was also precise computer simulation performed, in the environment of Esp-r application (University of Strathclyde, Glasgow), using real conditions and real building. The objective of this study was to examine feasibility of a log house design, showing excellent properties in terms of heating energy consumption located in Slovakia.
Key words: log houses, energy consumption, computer simulation, design, guidelines, zero energy houses

1. INTRODUCTION

To evaluate building designs, there are several advanced standards, as Ecohomes (BRE, UK), Passivhaus (Germany), AECB (UK), a LEED (USA). These standards use different rating scale while assessing energy efficiency (or zero energy use) in buildings. On the other hand, none of these standards provide neither particular strategies nor any design guidelines how to achieve zero energy consumptions for wood log houses – as these are essential for architects and engineers, also for dissemination of passive houses based on log construction.

Based on energy evaluation of buildings with positive index, it is necessary to focus on specific heating demand, which relates to high quality design of the entire external envelope in overall scale, to accommodate solar and internal heat gains. It is also important, that decreasing primary energy demand for heating, cooling, ventilation, hot water preparation and lighting, together with covering the energy demand by renewable sources, will become natural in next design procedures in construction industry.

Energy requirements for buildings have been developing over the years, similarly as thermal properties of external envelope. They were limited in national standards ČSN, later in STN, now in EN – or in ISO respectively. Energy efficiency is expressed by specific heating demand $Q_{H,nd}$ for continuous heating during heating season / a year. The calculation is based on building external volume Vb [m3] from external dimensions and structural height of floors, heat loss H [W/K] of floors, standardized degree-days D = 3 422 K.day, difference between internal and ambient temperature $\theta_{ai} - \theta_{ae}$ = 35 K, hygienic ventilation of n = 0,5 h^{-1} and total floor area ΣA_b [m^2]. Building satisfy the energy requirements if specific heating demand $Q_{H,nd} \leq Q_{H,nd,N}$, where $Q_{H,nd,N}$ is standardized heating demand [kWh/(m^2 . year)].

Some case studies were published to evaluate thermal behavior of buildings, but the buildings were merely silicate-based structures. Similar research considering wood log houses is not available in accessible sources.

The main objective of this study is to specify basic thermal properties of log houses, in correlation to current knowledge and research, with particular emphasis on reference object, where we focus on entire building as complex, not only on particular parts as walls, roof, etc. The study and the experiments should present that energy saving wood log house is feasible, with energy consumption balance definition. The thermal properties specification of log house construction plays key role while applying traditional elements into advanced building design, and still satisfying standards for modern family living.

According to needs, requirements and possible options of an energy facility owner, there are two types of energy audits - simple and detailed.

The objective of an energy audit is a report of the audit. To perform the audit, it is necessary to take following actions:

- mass and energy flows and balances,
- to draw proposals how to reduce energy flows, or mass flows respectively,
- to create a scheme of implementation of the proposals and to calculate savings.

The scope of the paper is to offer possible recommendations for next building design, based on scientific energy analysis with comparison to thermal monitoring on real reference log house

In relation to present demand for traditional wooden structures, information flow about thermal and energy behavior is not sufficient. Wang et al. is one of the few who deal with such a problem, describing and analyzing thermal behavior of traditional Chinese habitable building. „Indoor and outdoor air temperature, relative humidity, solar radiation intensity and wind speed were obtained by using field-tested methods for the traditional dwelling houses in this region in winter, and the clothing form and activity of people were surveyed by way of questionnaire. And then, the influence of house orientation, indoor heat sources and insulation on the indoor thermal environment is analyzed, the WCI (wind chill index) is used to evaluate the indoor and outdoor thermal environment at last. The results show that: the indoor temperature can raise about 8.3 °C when the house orientation is better and Chinese kang as the heating heat source. The good practice on local structure is worthy of following for other houses, such as adobe posted solid brick wall, double windows, wooden sash windows and so on.“ Wang et al. (2011). The authors are looking at the building as a complex, but unfortunately this particular building is made of brick.

Our reference object was a square log family house occupied during all year, where experimental research and observation was conducted. It could be said that wood structure design is becoming more popular also for multipurpose buildings, though these are mostly timber-frame structures. But the log structures are also used for such buildings, as traditional solution.

2. EXPERIMENT METHODOLOGY

- Theoretical analysis of the external envelope assemblies with calculation of U-values (as per STN 73 0540 „Thermal properties of building structures and buildings“).
- Temperature and air relative humidity monitoring on site, in real log houses.
- Energy consumption monitoring at operational conditions, according to STN 73 0550, with energy balance evaluation during heating season, while thermal comfort is considered.
- Precise simulation of the reference object in scientific application Esp-r.
- Comparison of theoretical analysis and experiment on real object.

Table 1. Apparatus description for the environment monitoring

Multichannel data logger AGILENT, designed to monitor interior air temperature, sensors were placed in compliance with STN 73 0550
Multichannel wireless data logger TFA 30.3015 - station with possibility of max. 5 external sensors, each for recording air temperature and air relative humidity
Weather station HOBO for monitoring of wind velocity and direction, ambient temperature, relative humidity, solar radiation

The scope of the monitoring is to state energy consumption for short period of 30 days (much shorter than a heating season). To transform this energy consumption to standard values, standard number of degree-days is used, according to procedure in STN 73 0550 „Energy consumption monitoring in operational conditions“. While performing the monitoring, instructions in STN 73 0550 need to be followed. We defined sensors placement after detailed inspection of the object and calculating it‘s thermal characteristics. Recorded data were analyzed after the monitoring and summarized.

The energy consumption determined by this standard is considered from point of measurement into heated space. This value represents so-called net energy, where heating system and related efficiencies of boiler, distribution and control does not need to be taken into account. The value can only include basement heat distribution efficiency. Such determined value reflects heat losses caused by thermal properties of building and ventilation, and does not account for energy inefficiency by burning fuel and distribution to the point of use.

Table 2. Parameters of monitoring

Recording of particular parameters:	- ambient air temperature θ_{ae} [°C] – sensor was placed in shaded box in area of free air flow, at height of 2.1m and 2.5m from the building, - ambient air relative humidity φ [%] – places as sensor $\theta_{ae,}$ - wind speed v_a [m/s]- sensor was placed in area of restriction-free area of air flow, 2.0m above ground level, - interior air temperature sensor θ_{ai} [°C] - sensor was placed in the middle of selected rooms, 1.5m above floor level, - interior relative humidity φ_{ai} [%] - places as sensor $\theta_{ai.}$
Monitoring period and recording intervals:	Intervals for recorded and observed parameters T [day,h] are even and are determined by requirements for their average day values. Indoor temperature interval can be max. 1 hour. For exterior air temperature, it is usually 1 h, but readings at time 7:00 – 14:00 – 21:00 are allowed. Energy consumption is recorded on the edge of the house. The interval is usually 1day (T=1) at the same time of the day. It is allowed to span the intervals, but max. to 7 days.
Recorded parameters:	- interior air temperature θ_{ai} [°C] at typical space of the building, - ambient air temperature θ_{ae} [°C], - heating energy consumption increment, at selected reading intervals.
Parameters observed:	- interior air relative humidity φ [%], - ambient air relative humidity φ [%], - wind speed v_a [m/s] and wind direction,, - solar radiation.

The Experiment was carried out on reference square-log building – family house, located in Ponická Huta, near Banská Bystrica (figure 1.).

Figure 1. South-east elevation of the reference object – square-log house, built in 2005

Table 3. The reference house characteristics – square log house, Ponická Huta

Archi-tectural arrange-ment:	-main entrance located from north side of the house, from gravel road, -the entrance is weather protected, but no fully closed, - central hall creates main communication space with stairway to first floor -the basement is not habitable space, it is used as a storage
External envelope assemblies:	-external wall consists of square logs 116mm, insulated to the interior by 120mm of glasswool between battens -external wall of the attic is timberframed, and includes 100/140mm studs, with glasswool insulation of 140mm,vertical wood cladding is used from both sides -floor of the basement is created by 150mm of steel reinforced cast concrete -ground floor is formed by 140mm of steel reinforced cast concrete + 80mm extruded polystyrene insulation -attic ceiling consists of rafter ties 160mm with glasswool insulation and wood cladding from interior -pitched roof is based on rafters 180/80mm with 180mm fiber insulation and wood cladding 2mmm from interior
Equipment	- hot-water space heating with natural circulation, designed. temp. difference is set to 90/70°C - electric hot-water boiler, uses advanced priced electricity - in 2010 there were flat solar panels mounted to south side of the roof - DHW (domestic hot water) is prepared in electric cylinder and in instantaneous electric heater
Orientation of the building	- south oriented openings area is 20% of total south oriented envelope - habitable zones have windows oriented to west and east - only necessary windows are north oriented
Area, volume, basic dimensions:	Built-up volume of building: V_b=476,5 m^3 Specific area of building: A_b=108,8 m^2 Built-up area: S=92,5 m^2 Structural height of attic: KVP = 2650 mm Structural height of ground floor: KVP_{1NP} = 2750 mm Structural height of basement: KVP_{2NP} = 2500 mm Habitable area S_1 = 98,1 m^2 (ground fl =48,7m^2 , attic = 49,4m^2)
	Heating energy consumption during January 2007 = 710 kWh

Table 4. Calculated overall heat transfer coefficient – U-value [W/(m^2.K)] for different wood parameters :

Envelope type	U_i [W/(m^2.K)]	U_i [W/(m^2.K)]
External wall	0,25	0,26
External wall - attic	0,182	0,19
Basement ceiling (reinforced cast concrete slab)	0,336	0,336
Insulated pitched rood	0,187	0,191
Windows	1,7	1,7
Entrance door	1,7	1,7
Attic ceiling (insulated rafter tie construction)	0,187	0191
Considered thermal conductivity of wood (λ)	λ [W/(m.K)] = 0,13	λ[W/(m.K)] = 0,18

Monitored data evaluation as per STN 73 0550 standard for the reference house:
Heating energy consumption for building floors, based on site monitoring: E_{bp} = 3,9 MWh/V_{bp}.year. There are individual average increments for energy consumption and temperature values presented in tab. 6, for interior and exterior. There are also relevant degree-days showed, determined by equation:

$$D_T = T(\theta_{i,pr} - \theta_{e,pr}) \quad (1)$$

D_T degree-days number [K.day]
T energy increments reading interval (in this particular case = 5)
$\theta_{i,pr}$ average day temperature for interior [°C]
$\theta_{e,pr}$ average day temperature for exterior [°C]

Table 5. Reference heating season and comparable standard conditions:

Building shape factor ΣAi/Vb [l/m]:	0,796/m
Number of degree-days during standard heating season:	D=3422K.day
Number of days during standard heating season:	d=617,78 days
Thermal bridges allowance ΔHTM [W/K]: ΔUΣAi	ΔHTM=37,9W/K
Specific heat loss by heat transition HT [W/K]: ΣbxUiAi + ΔUΣAi	λ_{wood} = 0,13 W/mK HT=160,9 W/K
	λ_{wood} = 0,18 W/mK HT=163,6 W/K
Internal gains Qi [kWh]: 5qiAb	Qi=3756kWh
Solar gains Qs [kWh]: ΣIsjΣ0,50gnjAnj	Qs=1526,4kWh
Utilization factor for heat gains:	η=0,95
Air change (hygienic minimum) n [l/h]:	0,5 l/h
Thermal parameter of building q [W/m3.K]:	23,95 W/m^3.K

Table 6. Monitored values of interior and exterior air temperature, heating energy increments and calculated relevant degree-days, with resultant energy – temperature correlation 0,97:

Day	Energy increments E_d [kWh]	Air temperature in individual zones [°C]				Average interior temperature $\theta_{i,pr}$ [°C]	Ambient air temperature $\theta_{e,pr}$ [°C]	Degree-days D_5 [K.day]
		$\theta_{ai,1}$	$\theta_{ai,2}$	$\theta_{ai,3}$	$\theta_{ai,4}$			
1.1.		24,94	23,2	26,48	24,86	24,87	-0,1	
2.1.		23,6	22,9	25,0	23,35	23,71	3,7	
3.1.	25,2	22,97	22,8	24,6	22,9	23,32	3,4	107,96
4.1.		23,0	22,5	24,9	23,3	23,43	1,0	
5.1.		24,25	22,98	25,4	23,9	24,13	,5	
6.1.		22,3	22,2	24,3	23,1	22,98	4,9	
7.1.		23,79	22,29	25,1	23,4	23,65	5,0	
8.1.	20,72	22,75	22,0	24,68	22,51	22,99	3,3	91,86
9.1.		21,97	21,6	23,4	21,7	22,17	4,8	
10.1.		22,25	21,7	24,3	22,1	22,59	4,5	
11.1.		22,3	21,8	24,2	22,7	22,75	6,1	
12.1.		22,14	21,85	23,5	21,9	22,35	6,0	
13.1.	20,96	23,87	22,5	24,6	23,4	23,59	7,8	88,20
14.1.		24,3	23,3	25,9	23,9	24,35	6,8	
15.1.		23,3	22,65	25,18	23,5	23,66	1,8	
16.1.		22,8	22,3	24,5	22,7	23,08	-0,3	
17.1.		22,8	22,1	23,9	22,6	22,85	0,9	
18.1.	22,54	22,61	22,26	24,3	22,42	22,90	4,0	97,44
19.1.		22,4	21,7	23,8	22,1	22,50	7,3	
20.1.		23,3	22,5	23,9	22,76	23,12	5,1	
21.1.		23,9	22,9	25,4	23,6	23,95	7,0	
22.1.		23,26	22,1	24,6	22,8	23,19	3,2	
23.1.	26,28	22,7	22,23	24,19	22,3	22,86	0,2	116,45
24.1.		23,6	22,5	24,8	23,1	23,5	-3,3	
25.1.		23,8	23,2	25,01	23,4	23,85	-6,2	
26.1.		24,4	23,9	25,3	24,1	24,43	-3,0	
27.1.		25,5	24,6	26,26	25,1	25,37	-0,3	
28.1.	26,82	24,86	24,7	25,9	24,6	25,02	1,5	117,37
29.1.		23,3	23,19	24,6	23,0	23,52	3,0	
30.1.		23,27	22,8	24,7	23,0	23,44	3,2	

3. RESULT AND DISCUSSION

Calculation proved specific heating energy demand at value of 70,7 kWh/m^2.y, while considering λ_{wood}=0,13 W/m.K, as value for softwood (heat flow perpendicular to grain) according to STN EN 12524 „Building materials and products. Thermal and moisture properties. Table design values“. If the thermal conductivity is changed to λ_{wood} =0,17 W/m.K, as per STN 73 0540 for building envelope structures,

specific heating energy demand does not change significantly – it increases by 1,1 kWh/m2.year to 71,7 kWh/m^2.year. Based on design calculations the house is rated between standard and energy efficient building.

Table 7. Calculated heating energy demand based on design scheme with considered natural ventilation n=0,5 h^{-1}, as required minimum hygienic value

λ_{wood} [W/m.K]	$Q_{H,nd}$ (design assessment) [kWh/m^2.year]	$Q_{H,nd,N}$ (required by STN 730540) [kWh/m^2.year]	$Q_{H,nd,r1}$ (recommended by STN 730540) [kWh/m^2.year]	$Q_{H,nd,max}$ (maximum limit by STN 730540) kWh/m^2.year]
0,13	70,7	85,4	42,7	112,6
0,18	71,7			

Table 8. Specific heating energy demand and thermal characteristic of the building according to STN 73 0550

Specific heating energy demand, real performance of the house E_2 [kWh/m2.year]	Specific heating energy demand, design assessment, STN 730550 $Q_{H.nd}$ [kWh/m2.year]	Thermal characteristic (heat flow from the building per 1m3 of the habitable space) q [W/m3.K]
20,9	21,2	23,95

Heating energy consumption based on the house monitoring is only 30% of the heating energy determined by design assessment (table 8.). It is visible, that STN calculation procedure does not represent real energy balance, despite that real climate conditions are used in the STN calculation. As the house shows excellent combination of overall design concept, insulation standard eliminating thermal bridges, high solar radiation use, using renewable energy source and intelligent behavior of habitants, it is easily possible that STN 73 0540 calculation procedure can be out of focus.
There was precise dynamic thermal simulation performed for the reference house, in ESP-r application (University of Strathclyde, Glasgow), using monitored data of real climate, during exact period. As a result, the complex thermal overview and the house behavior can be analyzed, also with thermal comfort of users and heating energy required, for any period of considered time.

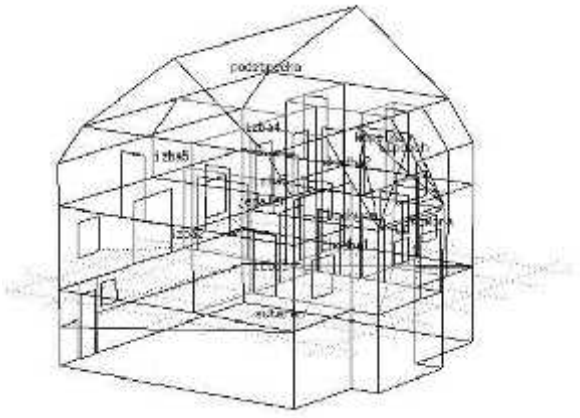


Figure 2. 3D model of the reference house, in Esp-r software (thermal zones)

The examined log house was processed in the ESP-r twice, for the same exterior parameters. Thermal conductivity of wood λ_{wood} was the only value that was modified. First, we used λ_{wood} = 0,18 W/(mK) as per STN 73 0540. In second step, it was changed to λ_{wood} = 0,13 W/(mK) as per STN EN 12524, due to reasons described earlier in the introduction.

Each room of the simulated house was modeled as independent thermal zone in the 3d model, as the rooms have different heat storage capabilities of partition walls and are occupied differently. The areas of the wireframe model surfaces represent heat-transfer walls with defined physical properties. Each zone has assigned its own simulation conditions and time profiles – parameters of heating, ventilation, occupation, internal gains, etc. - which are changing in time – dynamic conditions.

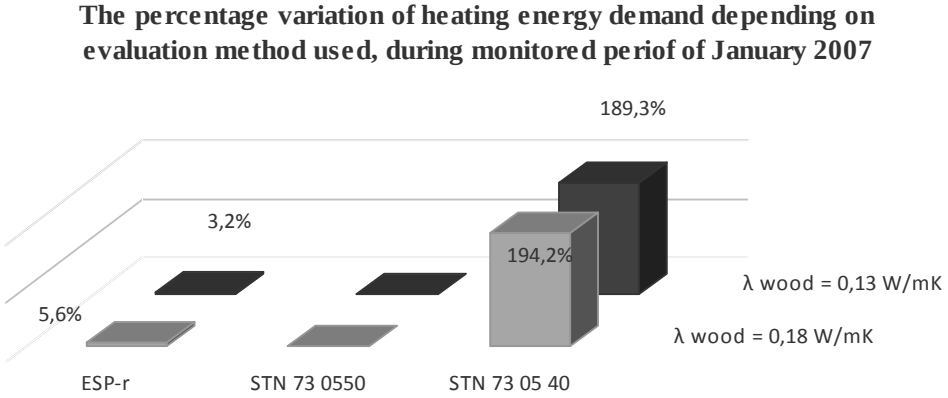


Figure 3. Variation of heating energy demand change for Esp-r simulation and design assessment by STN 73 0550, compared to real energy demand by STN 73 0550

Possible explanation for the noticeable differences in energy consumption is that solar gains only little affect STN 73 0540 calculation procedure. But, as visible from graphs, the solar gains can significantly contribute to gained energy and therefore decrease heating energy demand, as seen for case of the reference house. In Esp-r simulation, detailed solar gains modelling is natural part of simulation, and it is clearly visible from results that solar gains effect can not be omitted.

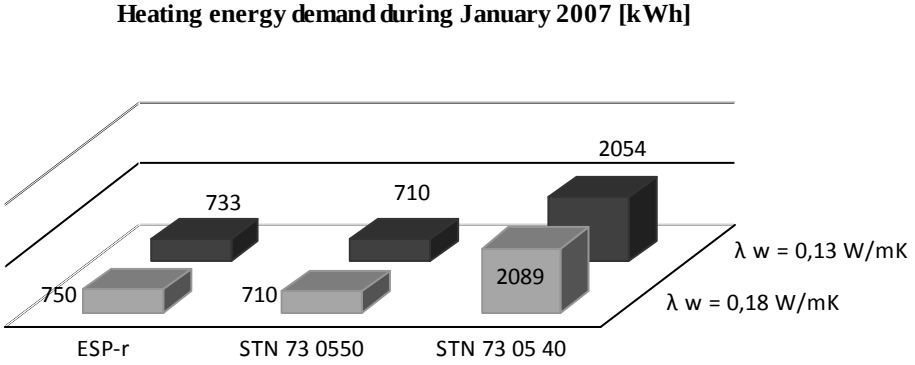


Figure 4. Heating energy demand for different λ_{wood} values, determined by – ESP-r simulation and STN 73 0550 calculation based on monitored data – STN 73 0540 design assessment

4. RESUME

Real electric energy demand for space heating is 710 kWh for the reference house, during observed period. For comparison, there is adequate consumption of selected types of fuel presented in table 9.

For such low energy demand during monitored period along with high thermal comfort of users, any of the fuel alternatives is acceptable. Despite of using relatively most expensive electric energy, the energy costs of 85,2 € per January is at least attractive for standard family house occupants. Taking into account heating energy expenses, comfortable indoor thermal-humidity environment and almost maintenance free living, the electric energy seems to be convenient solution.

The heating energy demand during the month from 1st. Jan. to 30th Jan. 2007 appears too low. For this particular house, while comparing different approaches of evaluation (ESP-r, STN 73 0550, STN 73 0540), the compared parameters clearly show disparity of the methods used. South and south-east glazing orientation points out how significantly the solar gains along with proper glazing parameters can affect heating energy consumption. Solar gains depend on glazing optical properties, window geometry and facade orientation.

Table 9.: Consumption and price of prevalent fuel types, for the reference log house

Heating energy demand for space heating	710kWh				
Fuel	Natural gas	Wood		Wood pellets	Elektric energy
		hard (beech)	Soft (spruce)		
Unit price	0,047 €/kWh	65 €/m^3 0,0,36 €/kWh	50 €/m^3 0,037 €/kWh	0,049 €/kWh	0,12 €/kWh
Price for fuel consumption	32,4 €	25,6 €	26,5 €	35,0 €	85,2 €

Sasaki et al. (2007) deal with above mentioned issues. Their study deals with the office building without using ESP-r simulation. They also unpublished methods of experiment.

In case of the reference house, after the change – energy transmittance of glass optimalization, and its integration into STN 73 0540 calculation, the heating energy demand has changed by 10% for the monitored period. Important influence is also showed by mean solar radiation intensity with direction I_{sj}, which is standardized by STN calculation procedure. But, significant impact to this value is caused by mean solar radiation at particular location, depending on local natural conditions – shading objects, altitude, air pollution, dirt on glazing, particular degree-days number.

However, air infiltration to the house by log wall structure and window gaps has the most important influence to heating energy demand. We found out, that the square-log wall is highly airtight, as there is double seal applied to joint between the square logs, and there is double tongue-and-groove formed.
Based on the site monitoring, analysis, simulation and the evaluation in previous chapters, we can state following remarks and recommendations for wooden log houses:

Different λ-values for wood λ_w = 0,13 a 0,18 in the calculation directly effect design assessment of energy heating demand. Thermal conductivity λ_w of 0,13 W/mK by STN EN 12524 „Building materials and products. Thermal and moisture properties. Table design values“ reflect real situation better. According to STN 73 0540 „Thermal properties of building structures and buildings“ the calculated energy demand is 15% higher than real consumption, while this higher draft value was confirmed for other reference log houses monitored later, but not presented in this paper.

Precise Esp-r simulation proved to be the most accurate method for heating energy demand prediction , while it shows realistic values at design stage. The simulation provided complex results for detailed energy flows and indoor environment parameters, while using calibrated 3D simulation model of the building.

Primary orientation of possible maximal window area to south and therefore eliminating north glazing are considered as basic and essential recommendation.

As air pollution is constantly increasing, and it negatively affects possible dirt on glazing, the focus should also be on clean windows, which guarantee optical comfort as well.

The design assessment of heating energy means contribution to standard building design and for comparative purposes. But, the absolute descriptive value can be partially out of focus due to excellent thermal properties of insulated wood log houses and their occupation. Therefore the design assessment should not be used for predicting absolute heating energy consumption.

Ventilation turned out to be the weakest point at thermal loss calculation. Because of variability of log wall design and sensitivity to air tightness, the air change n= 0,5 l/h per STN 73 0540 is not satisfactory. In real conditions, air tightness on-site testing is necessary to determine the natural ventilation. For Esp-r simulation, the air change had to be increased to app. 2 – 3 times higher than the minimal standard value, to achieve relevant real energy consumption.

Acknowledgements: This article was also supported by VEGA project no. V 14 – 006 – 00.

REFERENCES

1. Sasaki,M. ; Yanai, T.; Akimoto, T.: The Field Measurement of The Sustainable Office Building with The Environmental Adjustable Systems In: Proceedings of Clima 2007 WellBeing Indoors, Helsinki, Finland, 10-14 June, 2007, ISBN 978-952-99898-3-6.
2. Wang D. J.; Liu Y. F; Liu J. P.; Liu J. H.:"Thermal Environment of Traditional Dwelling Houses in Dry Hot and Dry Cold Climate Zone of China in Winter", Advanced Materials Research, Vols. 243-249, pp. 178-183, May. 2011
3. STN 73 0540 : 2013, „Thermal protection of buildings. Thermal properties of building structures and buildings“
4. STN EN ISO 14683: 2008, ‚Thermal brigsed in building structures. Linear thermal transmittance. Simplified methods and informative values“
5. STN 73 0550: 1998, „Energy consumption monitoring in operational conditions“

Authors address:
Búryová, Dominika*[1]; Sedlák, Pavol[1]
[1] Department of Wooden Construction, Faculty of Wood Sciences and Technology, Technical University in Zvolen, Zvolen, Slovak republic
*Corresponding author: buryova@tuzvo.sk, buryovadominika@yahoo.com

WOOD PRODUCTS USAGE IN RURAL TOURISM BUILDINGS

Pirc Barčić, A; Motik, D; Slivar, V; Hideg, I; Belina, L; Klanfar, F

ABSTRACT

Wood industry presents one of the most important sectors of Croatian economy, while rural tourism sector present one of the important parts of Croatian economy where a great degree of involvement of wood products usage is possible. This sector present opportunities for wood products and furniture producers in the context of designing and furnishing. Rural tourism includes set of all tourism services and activities that take place within rural areas, which is not necessarily a supplementary activity; the economy which generates additional income, but may be a professional activity. In spring 2016 email-based study of 320 tourist buildings of rural tourism in Croatia was conducted. The aim of the study was to identify possibilities of wood products usage in rural tourism buildings.

1. INTRODUCTION

Rural tourism includes set of all tourism services and activities that take place within rural areas, which is not necessarily a supplementary activity; the economy which generates additional income, but may be a professional activity (Baćac 2006). Wood industry presents one of the most important sectors of Croatian economy, while rural tourism sector present one of the important parts of Croatian economy where a great degree of involvement of wood products usage is possible. This sector present opportunities for wood products and furniture producers in the context of designing and furnishing. The aim of the study was to identify possibilities of wood products usage in rural tourism buildings.

2. MATERIALS AND METHODS

The sample frame for this research were 317 business subject of rural tourism in Croatia which were taken from the first national catalogue of rural tourism subjects 'Rural Toirism of Croatia') from 2015. All business subjects were located in Croatia. An email survey was the method used for surveying respondents for this study. This approach was selected because it is the most cost-effective method for surveying (Dillman, 2000) and also insures data collecting over a wide geographic area and low-cost data conversion (Zahs and Baker 2007).
Based on research objectives questionnaire was developed. A draft version of the questionnaire was pre-tested with five randomly sampled representatives from respondents. The questionnaire was revised, based on the pre-testing response before the final emailing.

The questionnaire consisted of 17 questions and was divided into three sections: general information, information about wwood products usage in rural tourism buildings and eelements of decision process in buying wood products. Amultiple-item scales based on Churchill (1979) observations that no single item is likely to provide a perfect representation of the general idea was used of some questions. Furthermore, five-point Likert items, ranging from 1 (strongly disagree) to 5 (strongly agree) or ranging from 1(very unimportant) to 5 (very important) were also used. For some variables multi choice item measure was used because according to Thorndike (1967) cited by Lewis-Beck et al. (2004) multi choice item measures can be a superior to a single, straightforward question. The survey was conducted during the spring 2016. The total number of usable surveys received was 47 with adjusted response rate of 15%.

3. RESULTS AND DISCUSSION

3.1. Respondents profile

Given that domain of this research was tourism in rural areas, it was expected that a majority of respondents would come from rural areas of Croatia. According to results 53% of 47 respondent rural tourism objects were located in area with less than 1000 inhabitants. Additionally, considering that there are only nine cities in Croatia with more than 20 000 inhabitants and that in this research there was no respondents from areas with more than 15 000 people, it can be noted that almost 85% of respondents were from rural places of Croatia.

Respondents were asked to indicate there years in business. The oldest respondent rural tourism building was established in 1983, while the youngest was established in 2014. Over all of the 47 respondent tourist rural business were relatively young considering that the average age of years in business was 10 years. It is possible that this presents a year in which business was officially opened/established and when owners of the buildings decided to start working in rural tourism business, but the buildings (houses,…) were built before in the past. This can be sustained by result that almost 97% of respondent rural tourist buildings were privately owned, of which 80% were family inheritance, while 18% of this 97% privately owned buildings were bought from private persons with aim to work in rural tourism business. Only 3% of respondents noted that they have the lease contract to owners of the tourist building. The average age of rural tourism building was 62.4 years. The oldest building is from the year 1836., while the newest was built in 2012.

The total numebr of people employed in 47 respndent rural tourism businesses was 164 persons (minimun number of people per company/object was 1, while maximun number of emoployees per company was 23). Respondets were also asked to indicate percent of male and female employees. According 47 respondents, 51% of total employees number were male while 49% of total number of employees were female. Respondents further were asked to indicate their employee's age and education levels. Both, age and education were classified into six categories. As shown in Table 1, according to the 47 respondents, more than half (55.3%) were people between 41 and 60 years old, while 18.8 %percent were young people (between 18 and 30 years old). Only, 6.1% of employees were people older than sixty. Further, based on the 47 respondents educational structure of employees was obtained. Almost sixty two percent of total employee's number were people with high school education, followed by employees who have some college graduate degree (14.6%) and graduate degree (12.3%). Of total number of employees, 10.9% were people without any education, while only 0.6% were graduate people with competed Master's degrees or Ph.D.

Table 1. Employees gender, education, and age structure in the rural tourism buildings

Gender (%)		Education level (%)		Age groups (%)	
Male	51	No education	10.9	18 – 30 years old	18.8
		High school	61.6	31 – 40 years old	24.4
Female	49	College graduate	14.6	41 – 50 years old	30.9
		Graduate degree	12.3	51 – 60 years old	21.8
		M.s./Ph.D.	0.6	Older than 60	6.1

3.2. Wood products usage in rural tourism buildings

Respondents were requested to define wood products that they have in their rural tourism buildings. As shown in Figure 1, of the 47 respondents, 87.23% of them have interior wooden joinery (doors), followed by exterior joinery (85.11%), sitting furniture (82.98%), beds (76.6%)m and closets in the form of cupboards, wardrobes, bookcases (76.6%). Wood products like, kitchen and dining furniture, venetian blinds, floor coverings were used between 55% and 65% of the respondents. Additionally, wooden wall coverings (38.30%), wooden

facades (29.79%), and upholster furniture (29.79%) were products present between less than 40% of the respondents.

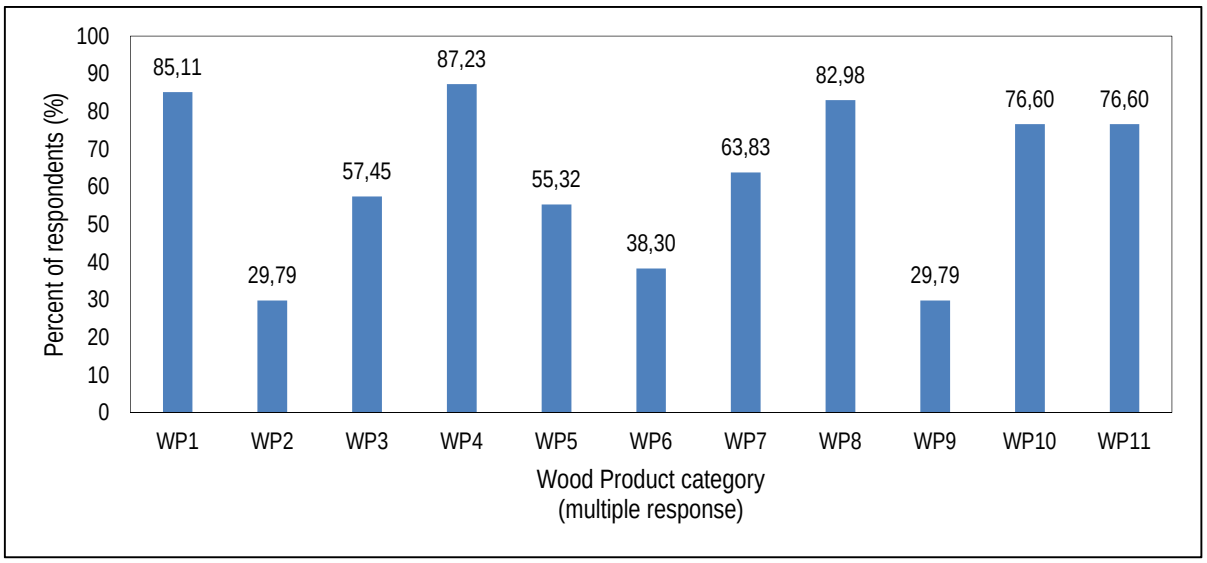


Figure 1. Wood product category in rural tourism buildings (n=47)

Legend: WP1 – exterior joinery (windows, doors, ...); WP2 – wooden facades (fronts of the buildings); WP3 – venetian blinds; WP4 – interior joinery; WP5 – floor coverings (parquet, rustic flooring, decking); WP6 – wall coverings; WP7 – kitchen and dining room furniture; WP8 – sitting furniture (bench, chair); WP9 – upholster furniture (armchair; sofa); WP10 – beds; WP11 – closets (cupboards, wardrobes; bookcases).

Respondents were required to indicate their level of agreement of disagreement about material preference in furnishing and equipping interior and exterior of their rural tourism buildings. As seen in Figure 2, 79.07% respondents strongly agreed that they prefer massive wood in interior design/furnishing, while 72.9% strongly disagree that they would use plastic as material in furnishing interior. Further, almost twelve percent (11.63%) of respondents strongly agreed that they would choose combination of different material in furnishing and equipping the interior of their rural tourism buildings. When the 43 respondents were asked to define level of agreement/disagreement on a 5-point Liker scale in material category preference as shown in Figure 3, more than ¾ (76.74%) respondents noted massive wood as the most suitable material for exterior design of their rural tourism buildings. Plastic was the material that respondents noted as the most unfavorable in exterior furnishing (58.14%).

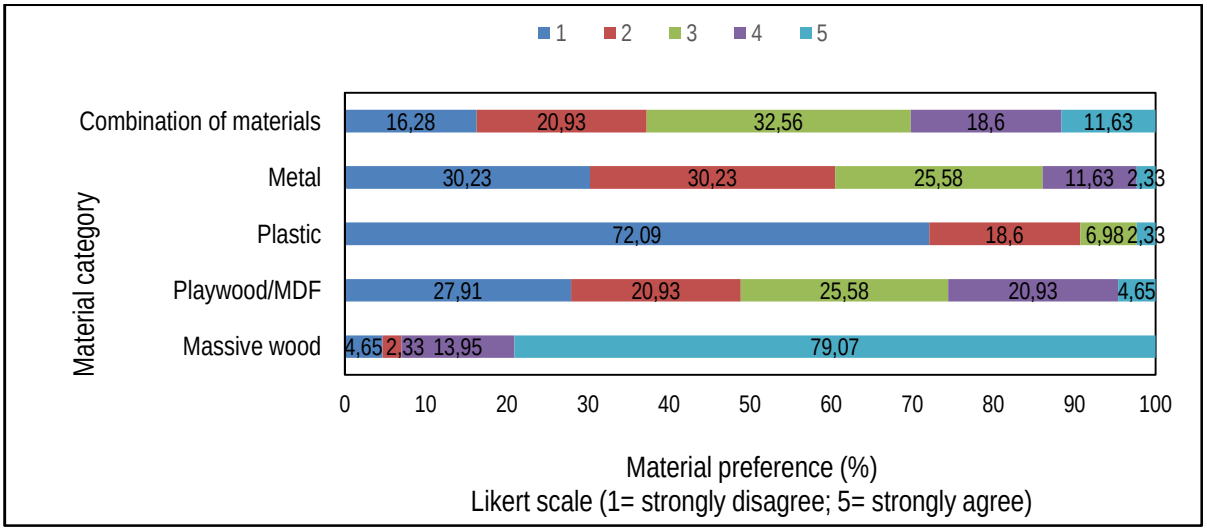


Figure 2. Material category preference of INTERIOR equipment in rural tourism buildings (n=43)

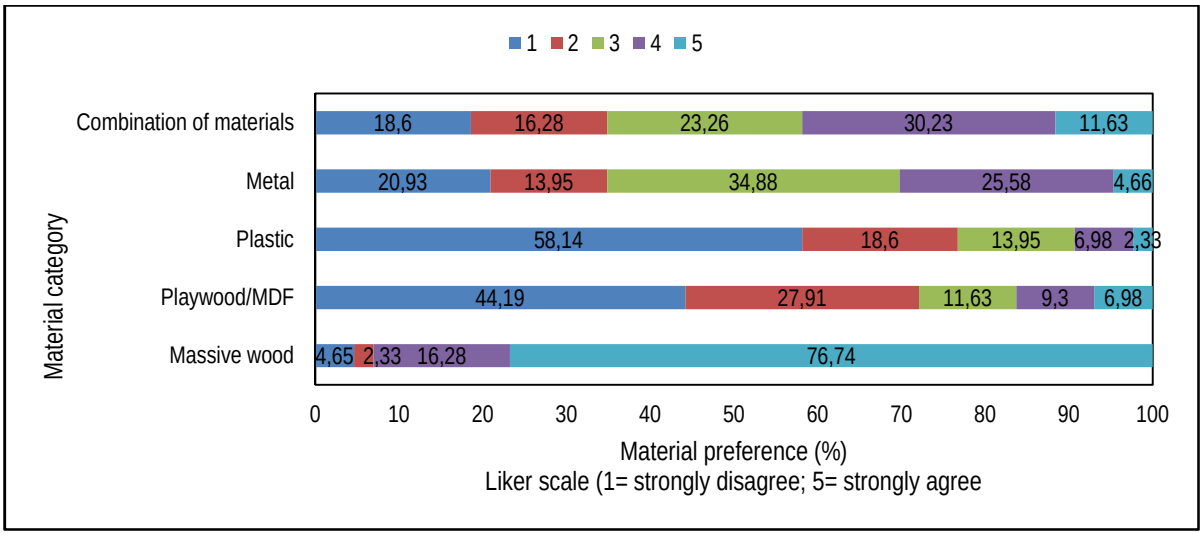


Figure 3. Material category preference of EXTERIOR equipment in rural tourism buildings (n=43)

3.3. Elements of decision process in buying wood products

In furnishing and/or renovation of their rural tourism buildings majority of the 37 respondents (70.27%) favor Croatian wood furniture and products. In addition, the respondents noted that they would equally buy Croatian furniture in the furniture store or directly form Croatian furniture manufacturer. On the other hand, 26.19% of the respondents prefer foreign wooden furniture and products.

When the 43 respondents were asked to define importance in a 5-point Liker scale about product factor elements in decision process of buying wooden products for their rural tourism buildings as shown in Figure 4, almost ¾ of respondents (72.09%) noted 'quality' as very important element, followed by 'product functionality' (60.45%), and design of products (55.81%). Furthermore, between respondents 'safety' was also one of definitely very important factor in decision making process of buying wooden products. On the other hand, factor 'price' was found not to be so important factor in decision process of buying wood furniture, only 29.73% of the respondents noted factor 'price' as very important element when buying a wood products for their rural tourism buildings.

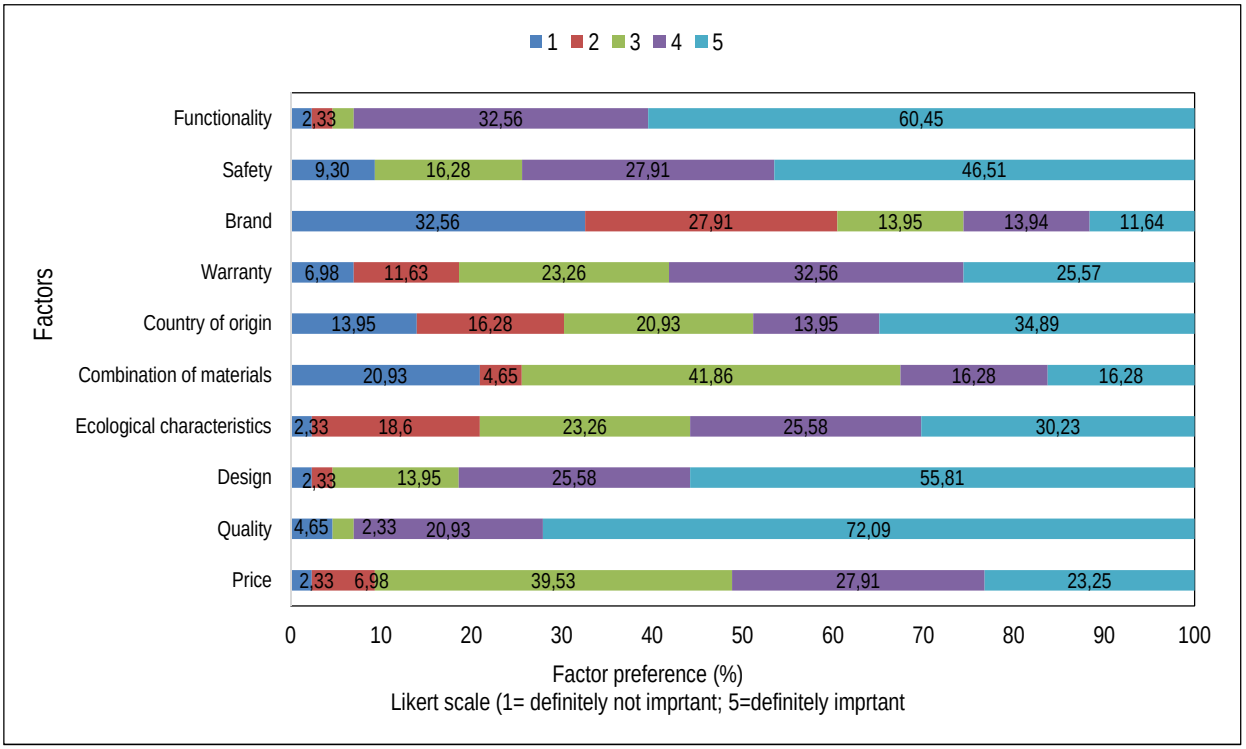


Figure 4. Factors in decision making process of buying wood products for rural tourism buildings (n=43)

4. SUMMARY

When deciding about type of material in equipping interior of owners/stewards of rural tourism buildings prefer 'real' massive wood, followed by combination of materials, while the most unfavourable material were plastic and metal. In equipping outdoor space the respondents would mostly use also, massive wood and combination of materials.

Quality of wood products was found to be the most important factor in decision making process of buying furniture and wood products, flowed by product functionality, product design, safety, country of origin, environmental characteristics, warranty, price, material combination and as the most insignificant factor was brand. In making decision about foreign of Croatian furniture majority of owners/stewards prefer Croatian wood products and furniture what was a logical choice, given that respondents were traditional Croatian rural tourism object in which all activates are based on Croatian tradition and inheritance. In Croatia rural tourism present a very important segment for wood furniture and wood product manufacturers. Owner and/or stewards of this places were noted as potential buyers and users of wooden products, so for wood furniture company managers was very important to get insights into situation, needs and possibilities of this rural tourism buildings.

REFERENCES

1. Baćac, R. (2006): Agroturizam - tradicijske vrijednosti u funkciji turizma. U: Petrović Leš, T., Pletenac, T. (ur.) Zbornik radova Etnologija i kulturni turizam. Zagreb: Filozofski fakultet – Odsjek za etnologiju i kulturnu antropologiju., str. 36.
2. Baćac, R. (2011): Priručnik za bavljenje seoskim turizmom – korak po korak od ideje do uspješnog poslovanja. Zagreb: Ministarstvo turizma Republike Hrvatske.
3. Dillman, D. A. (2000): Mail and internet surveys: The tailored design method, 2000.
4. Zahs, D. and Baker, R. (2007): Telephone and Mail Surveys: Advantages and Disadvantages of Each,.
5. **** (2015): Nacionalni katalog ruralnog turizma Hrvatske; Ministarstvo turizma Republike Hrvatske, Hrvatska gospodarska komora, Zagreb

Authors address:

Pirc Barčić, Andreja[1*]; Motik, Darko[1]; Slivar, Valentino[2]; Hideg, Ivana[2]; Belina, Lovro[2]; Klanfar, Franciska[2]

[1] Department for Production Organization, Faculty of Forestry, University of Zagreb, Zagreb, Croatia
[2]Students of Master degree program at Wood technology department, Faculty of Forestry, University of Zagreb, Croatia
*Corresponding author: apirc@sumfak.hr

THE IMPLEMENTATION OF PROCEDURES ENSURING THE PRODUCT QUALITY IN THE WOODEN CONSTRUCTION INDUSTRY ENTERPRISE

Stasiak-Betlejewska, R.

ABSTRACT

The quality formation in the woodworking company covers every aspect of the management, as concerns the sphere of production organization, process materials and information flow, machinery and equipment maintenance, training and supervision of product under quality standards. The whole of the quality assurance procedures in the company are included in the Quality Book of the enterprise. Paper presents chosen case of the wooden construction industry enterprise implementing quality procedures to improve the production performance.

Key words: woodworking company, quality, standards, procedure

1. INTRODUCTION

The quality formation in the enterprise includes every aspect of the enterprise activity: a production organization, an organization of process materials, information flow, maintenance of machinery and equipment, training, nonconformities supervision [Bešker et all 2016; Novaková and Škúrková 2016]. The whole of quality assurance procedures in the company are included in the Quality Book of the enterprise.

Contemporary enterprises apply Total Quality Management which is a management procedure aimed at the improvement, the effectiveness and competitiveness of the enterprise activities in the market. Conditions that characterized a quality management system as the integrated management system should [Jelačić 1995; Potkány and Benková 2008; Prístavka and Hrubec 2010, Ulewicz 2014; Blašková et all 2015]:

- implement and supervise policies and clearly defined objectives,
- describe, select and control over the process convenient for the organization what is a process approach,
- supervise the quality of the control measurements and research findings and the improvement process of the organization and the final products,
- manage all the company's resources adequately to the employees needs and production processes,
- Take effective way to communicate with the recipients in order to identify their desires, wishes and requirements and what is important - satisfaction with the cooperation.

Effective implementing and using ISO system is determined by its appropriate understanding and adapting to the needs of a particular organization to be assimilate with the particular requirements of the standard.

The introduction of the quality system in an organization requires, inter alia, fulfilment of following conditions whose realization influents on the high efficiency of procedures supportive for the high quality products achievement:

1. The management staff involvement that is interpreted as the need to engage senior management and its responsibility for the implementation and maintenance of the quality system.
2. The quality system that must be designed, implemented, and most importantly documented.
3. Supervision of data and documents - all documents must be checked and monitored in order to check its validity authenticity by designated employees. The changes in the documentation must be subjected to the same procedures review and approval as the original documents.
4. Purchases must be obtained from suppliers that meet quality criteria.

5. Identification of the product - the identification of specific product elements in some cases it must be possible, even during the production process. The documentation of the production processes allows reconstructing the production process; diagnose causes of nonconformities occurrence and location of the problem, correction and prevention in order to eliminate the "failure" in the future.
6. The process steering should ensure appropriate conditions of the production processes realization to be controlled effectively.
7. The inspection and research that concern products, deliveries or processes should be documented in the appropriate procedures.
8. The procedures for product that don't meet customers' requirements should concern elaborated and applied procedures explaining how to deal with products not meeting the quality requirements and explaining the eligibility selection of these products for the repair, alteration or ultimately scrapping. It is aimed at protection against the transfer of products not meeting quality requirements for further processing and prevents the possibility of delivery to the co-operating companies or the final customer.
9. Corrective and preventive actions - procedures of the possible nonconformities occurrence causes analysis, both in terms of a product and a process, and to take corrective action - should be established and followed.
10. Controlling the quality documentation - it is necessary to conduct provisions or procedures for filling, registration and storage of documents. The procedure for storage should allow quick and easy access to authorized people and prevent access to third parties.
11. Internal quality audits - should be carried out in the enterprise as planned and documented internal quality audits to verify and activities carried out within its framework in accordance with the applicable procedures. The essence of this issue relates to compliance with the quality policy of the organization and its effectiveness. The results of this work should include proposals for corrective actions and their verification, and, of course, to document their effectiveness. They must be made available to the persons responsible for the business area.
12. Training focused on the constant improvement of the workers skills and qualifications.

2. RESEARCH OBJECT CHARACTERISTIC

Analyzing process of the quality product formation through a proper organization of the production process in the chosen construction enterprise it was noted that there are implemented the quality maintenance and the quality growth procedures (illustrated in Figure 1) which apply to each division, department, or even each workplace. Each of these components of the process organization are supported by the Quality Plans based on the quality objectives created for the different "owners" of the processes. It should be noted that the owners of these processes (employees) are one of the most important element with regard to the purpose of a specific quality requirements. Company policy in this regard is not only the constant awareness of the staff about the mission and vision of the quality, but it also includes training and the personnel qualification that are solid and adequate to the enterprise objectives.

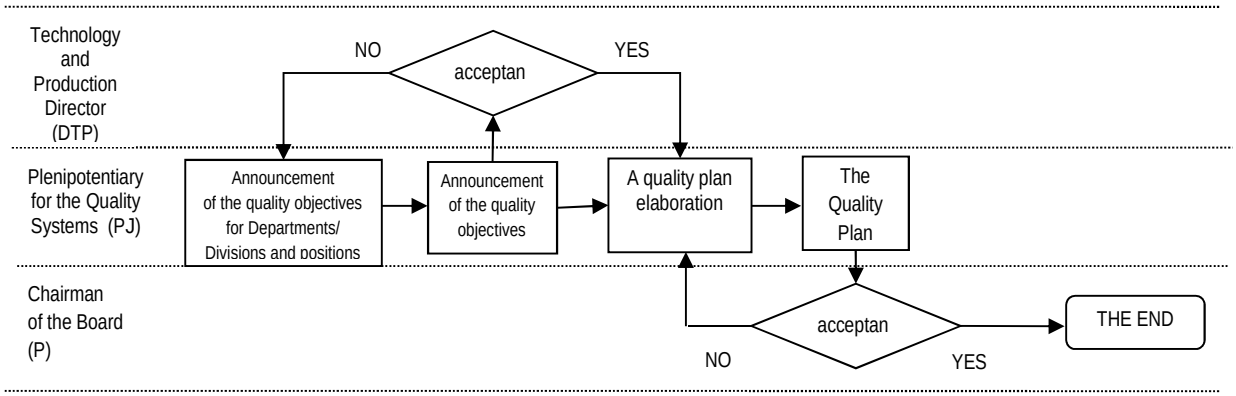


Figure 1. The procedure of the quality maintenance and constant quality growth in the chosen wooden construction industry enterprise.

The analyzed enterprise bases its production on the qualified suppliers, whose evaluation and selection is carried out in a permanent manner by creating the specified group of suppliers grouping them into categories A, B and C. The specific category choice for selected suppliers is determined by the results of tests on the supplies and the point value granted to individual providers is affected by such factors as:

- the trading ability which is determined for individual suppliers based on the price stability, payment terms, delivery punctuality and suppliers' flexibility to quantitatively-assortment changes,
- the quality ability whose the level is determined based on such factors as the number of complaint deliveries (value, quantity), the percentage of the complaint delivery and the complaint reasons.

The final grade, received by individual suppliers is affected moreover by the quality certificate and the date of certificate validity. The enterprise emphasises a dynamic approach to determining qualified suppliers process. Each list of qualified suppliers is established quarterly. Moreover, in determining the supply sources as well as the supply, the senior management has set a policy in the field that is realized by Head of Supply and Transport, and which is manifested in the following assumptions:

- purchase of materials and raw materials contained in approved articles by a certificate of conformity or declaration of conformity - the purchase by qualified suppliers,
- ensuring the safety of products shipped to the customer - measured by the quantity and quality of transport damage,
- ensuring a timber quality by: a proper drying, seasoning in accordance with the requirements, a proper storage, maintenance of normative stocks.

In detail, the process of delivering materials and raw materials for the production of wooden joinery was elaborated by the analyzed wooden construction enterprise in the following records. Purchasing department realized the production materials purchase on the basis of annual , monthly orders, ad hoc, annual contracts and imports (on the basis of the contract). Each issued in the purchasing department order is being recorded, has a serial number, date of issue, address of the supplier, the name of the requested material, the amount of the ordered materials, required Polish Standard, the factory or technical requirements, delivery, method of payment, way of material receiving. Ordered materials for wooden joinery production are delivered on the basis of the order. The materials delivery schedules are establihsed, depending on the needs of the month, week or a day delivery, with suppliers. Deliveries are usually provided or received from the manufacturer (supplier) by the means of suppliers' transport. Materials delivered to the factory is supervised in terms of the quality through the sorter from the Quality Control Department. Depending on the kind of a material the supervision concerns:

- in the case of a timber: a thickness, a width, a length, a grade for compliance with PN-75/D-96000 or factory standards,
- in the case of a fibreboard – thickness and size of plates are tested, and there are taken samples from each batch and they are tested by the enterprise laboratory in terms of a water absorption and swelling,
- painting materials – are examined by the enterprise laboratory,
- building hardware - the quality and performance of compliance with the PN or the WTO.

An important element of the process improvement are the people. Therefore, the policy of the top management of the analyzed enterprise is, among others, indification of the work meaningfulness. It awakens new capabilities of employees, their new energy and new imagination that allow to find new solutions. Creativity is the main attribute, which today is required from the personnel by senior management. However, employees creativity development requires an appropriate "handling people", that involves:

- continuous listening to opinions, comments and proposals of workers (e.g. due to working in teams seeking and shaping the quality - the idea of the quality circles),
- eliminating the causes of failures, not "treating the symptoms". This approach, manifested in honest conversations about all the problems, discussing misunderstandings and conflicts, makes it appear the atmosphere in which we all interact with each other, creating a unique and well-positioned to create quality,
- treatment of subordinates in priority, which means that developing the skills of subordinates is more important than achieving financial goals for the qualifications, experience and ability to think creatively; treatment of the personnel as the source of many ideas for improving the woodworking construction products quality; invaluable concepts enable reductions of any nonconformities.

3. RESEARCH FINDINGS AND DICUSSION

Information on how important the employees skills and qualifications development to functioning of the enterprise is, was evidenced by the fact of the qualifications plan continuous development, i.e. training, both in terms of its scope, purpose, time and destiny. Figure 2 presents the procedure for creating a training plan in the analyzed enterprise including assumptions of the quality constants improvement. The model assumes that only emplyees know all details of the realized operations in the processes and problems resulting from the processes failures and possibilities of efficiency improvement. Without full and conscious workers integration in the organization it is impossible to achieve its objectives. The application of this principle is supported by the principle of management involvement.

The other aspect of the quality formation and ensuring in the analyzed enterprise is an aspect of the supervision on the nonconformities. In the analyzed woodworking industry enterprise, there was elaborated a procedure focused on the quality management system improvement realized by indicating and eliminating nonconformities and potential failures related to the product quality or the entire quality manangement system functioning in the enterprise. The procedure is applied in the entire enterprise in all processes connected with realization, supervision and assessment of the corrective and preventive activities that result from the obtained information about nonconformities or potential failures connected with products or the quality management system functioning.

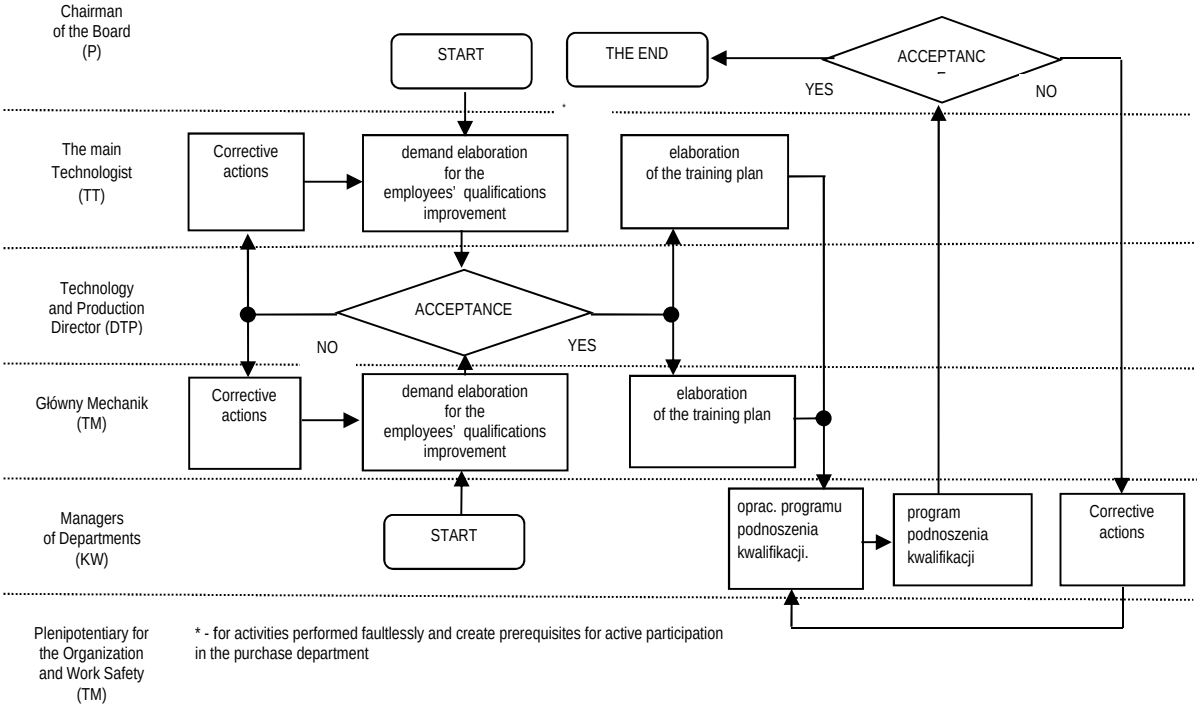


Figure 2. The elaboration of the employees' qualification improvement plan procedure in the selected wooden construction industry enterprise.

The scope of managers duties and their responsibility related to the implementation of this procedure is as follows (described also in Figure 3):

- the owner of the process (W) – oversees compliance with procedures and approve changes,
- Plenipotentiary for the Quality Systems (PJ):
  - collects and analyzes data on the product quality and the quality management system,
  - prepares and initiates The Application on Preventive/Corrective Action,
  - supervise preventive and corrective actions,
  - estimates preventive and corrective actions,
  - is responsible for the implementation of this procedure and for its improvement,
- Fields' Managers (KO):
  - elaborate and maintan preventive and corrective measures to delete identified nonconformities in the field of occurrence,
  - report to PJ reported noted or potential nonoconformities,
- Machines' operators (OP):
  - report to PJ or direct supervisor noted or potential nonconformities,
  - cooperates in nonconformities deleting in the own field of activity.

Corrective and preventive action are initiated on the basis of: internal audits, external audits, customer complaints, complaints of internal management review. In addition, each employee is required to report noted or potential nonconformities, which can not be deleted on their own, to the fields' managers (KO). The field manager reports nonconformities to Plenipotentiary for the Quality Systems (PJ) by using business memo. On the basis of that information PJ assesses the validity of the problem. If it deems it necessary, a corrective/preventive measures are initiated, whose course is described in the Application of Corrective/Preventive action adoption. It is recorded in the Register of

Corrective/Preventive actions led by PJ (details of the procedure shows the algorithm presented in Figure 3).

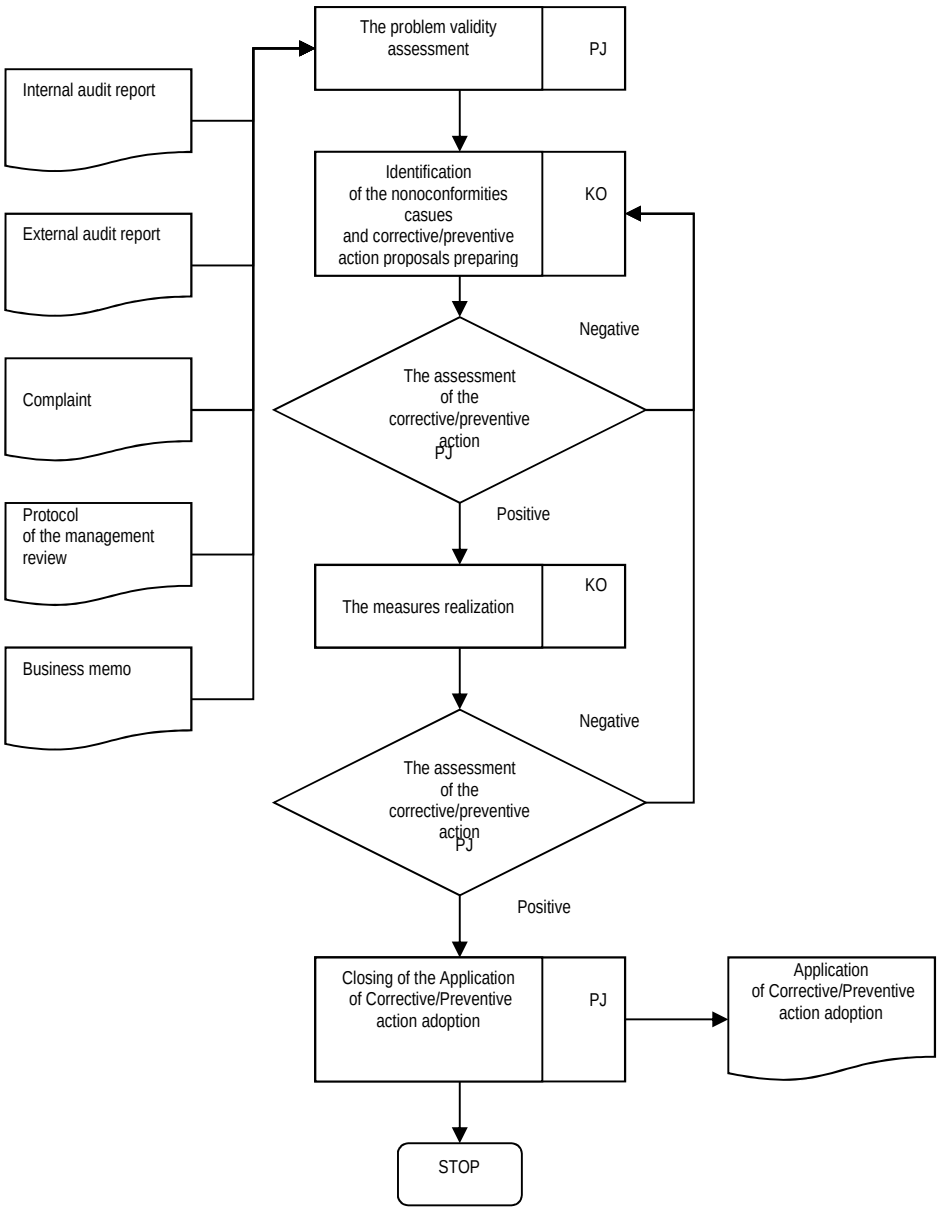


Figure 3. Algorithm of nonconformities supervision in the process realization.

The field manager is responsible for the realization of activities occuring in the nonconformities area. To implement further action, the field manager may designate an employee or team of employees. The designated employee or team of employees determines the cause of nonconformities and propose corrective and preventive actions. The proposed corrective and preventive actions are assessed by PJ. In the case of a negative assessment, there is proposed re-defining the causes and identifying other measures to solve the problem. If the assessment is positive, the designated employee or team start to implement the proposed action. Implemented activities are assessed by PJ. If the assessment is

negative, there is suggested the identification of nonconformities causes and preparing the new proposals on the problem solving. The positive assessment of the application request causes its closing.

4. CONCLUSION

The quality assurance is largely derived from appropriate organization of the production process and in the analyzed company, there is still implemented maintenance and quality growth procedure which applies to each division, department, or even work position. Applied procedures results from the integrated components of the quality management system implemented in the enterprise in accordance to objectives identified in the Quality Book. Responsibility for the processes results is the object of an evaluation and an improvement in the form of training aimed at the final quality improvement. It confirms that workers are an important element of process improvement.

The general quality management system improvement requires integrated measures within the quality policy as the result of the cooperation of the managers and subordinates who are the processes' owners. The feedback from the employees group is the crucial element of each proposed here procedure what enables the mangers define problems and find the appropriate solution in the team work process.

REFERENCES

1. Bešker, M, Čićek, J., Drlijača, M. (2016): Environmental Aspects with Particular Reference on Waste Management According to Norm ISO 14001:2015/E/, In: Proceedings 17 International Symposium on Quality "Quality makes a difference", 16 – 18 March 2016, Zadar, Croatia.
2. Blašková, M., Bizik, M., Jankal, R. (2015): Model of decision making in motivating employees and managers, Engineering Economics, Vol. 26.
3. Jelačić, D. (1995): Total Quality Management u sustavima upravljanja proizvodnjom, međunarodno savjetovanje "Osiguranje i upravljanje kvalitetom - kvaliteta proizvoda uz pomoć znanosti", Šumarski fakultet Sveučilišta u Zagrebu, Opatija, Hrvatska.
4. Novaková, R., Lestyánszka – Škúrková, K. (2016): Quality Management as Part Smart Policies of the Region – the New Mindset in Public Administration, In: Proceedings 17 International Symposium on Quality "Quality makes a difference", 16 – 18 March 2016, Zadar, Croatia.
5. Prístavka, M., Hrubec, J., (2010): Integrovaný manažérsky systém. In: Zborník z 15. Medzinárodnej vedeckej konferencie Kvalita a spoľahlivosť technických systémov 2010, Nitra 25.-26.5.2010. SPU v Nitre.
6. Potkány, M., Benková, E. (2008): Company processes - the basic condition for outsourcing use. In: Wood processing and furniture production in south east and central Europe: Innovation and competitiveness 2008, edit. Faculty of Forestry of Beograde University.
7. Ulewicz, R. (2014): Application of Servqual method for evaluation of quality of educational services at the University of higher education. Polish Journal of Management Studies, Vol. 9.

Author's address:
Stasiak-Betlejewska, Renata*[1]
[1] Institute of Production Engineering, Faculty of Management, Częstochowa University of Technology, Poland
*Corresponding author: renatastasiak@wp.pl

DIFFERENT PROFILES OF BRAND PERSONALITY – THE RESULT OF TWO INDEPENDENT MEASUREMENTS

Maťová, H.; Triznová, M.; Dzian, M.

ABSTRACT

The aim of this paper is to characterise enterprise as a personality. A research compares customers perceptions on two furniture sellers – IKEA and Möbelix, during two years. Based on the results it defines each company by human characteristics. The result is "corporate personality profile" for each company. To identify profiles Geunes, Weijters and De Wulf (2009) method has been used. The first research study was carried out in 2015 and the second research study was carried out in 2016 on two independent samples of respondents. It resulted in four different profiles of brands and recommendations for further research.
Key words: brand personality, corporate personality profile, furniture sellers

1. INTRODUCTION

As was mentioned by Kaputa, Paluš, Vlosky (2015 p. 121) the main competitive advantage of the Slovak wood processing companies in foreign markets is related to price. They also see opportunity to change it by using non-price factors.

Customers with positive attitude towards the company, loyal customers and satisfied customers are the way how to measure the real success of the company on the market in general. These facts were mentioned in some studies e.g. (Loučanová et al. 2014), (Parobek et al. 2015) etc.

The main aim of this paper is to reveal the brand personality profiles of IKEA and Möbelix (furniture sellers on the Slovak market) using the new measure of the brand personality (NMBP) which was developed by Geuenes, Weijters and De Wulf (2009) and to compare them to results of our previous study which is in print. The first research was carried out in 2015 and the second research was carried out in 2016 on two independent samples of respondents.

This method can help to reveal brand personality profile which we want to use to reveal the attitudes of the consumer towards the selected companies.

2. MATERIAL AND METHODS

In our two studies carried out in 2015 and 2016 on two different samples we tested a new measure for brand personality developed by Geuens, Weijters, de Wulf (2009). This measure consists of twelve items and five factors – Activity, Responsibility, Aggressiveness, Simplicity and Emotionality (see table 1). They used a 7-point Likert scale to rate brand on 12 brand personality items.

We translated all items from this scale to Slovak language and constructed a questionnaire. Respondents were asked to rate brand personality traits on a Likert-type scale. The respondents rated 12 items on the scale from 1 – strongly agree, 3 – neither agree nor disagree (neutral answer, the midpoint of the scale) to 5 – strongly disagree.

There are several other authors dealing with the issue of brand personality measure e.g. Jenifer Aaker (1997) was the first who tried to create and construct a valid scale to measure brand personality in US (Whelan and Davies. 2007). The Corporate Character Scale method developed and tested by Davies et al. (2001, 2004) is used to measure the image and the identity of the companies. Milas and Mlačić (2007) created Croatian scale and Bosnjak et al. (2007) German scale. Haji et al. (2012 p. 449)

identified four antecedent constructs for Negative Brand Personality: Corporate Social Irresponsibility, Self-Incongruence, Brand Confusion, and Price Unfairness. As for Negative Brand Personality we want to use this scale for our further research.

Table 1. The new brand personality measure (Geuens, Weijters, de Wulf 2009 p. 103).

Dimension	Items
Responsibility	Down to earth Stable Responsible
Activity	Active Dynamic Innovative
Aggressiveness	Aggressive Bold
Simplicity	Ordinary Simple
Emotionality	Romantic Sentimental

The sample I consisted of 409 respondents (consumers). We gathered data during November and December 2015. The sample II consisted of 467 respondents and data were collected during March and April 2016. The snowball sampling technique was used (non-probability sampling technique) because we needed respondents that had knowledge and experience with both IKEA and Möbelix companies. Face to face interviews were carried out in both researches. As for selected time periods for research studies, Christmas time period and spring were selected because of increasing demand for furnishing items in Slovak republic.

For data analysis we used the weighted mean score on the 5-pointing rating scale for both companies as for scale dimensions (see figure 1 and 2). We used mode and weighted mean as well (see Table 2) for items of the dimensions of the scale.

3. RESULTS

The table 2 shows the results of our two research studies (IKEA I and Möbelix I – these results are from our study which is in print; IKEA II and Möbelix II are results from our new research which was conducted in 2016.)

The basic results of first survey (conducted in 2015) are: approximately 55.3% of the respondents were female and 44.7% were male. All respondents were over the age of 18 years old. More than 65% of the respondents were under the age of 51. As for the economic status, more than 50% were employees, more than 15% were students and more than 11% represented entrepreneurs. Approximately 60% of respondents lived in the cities.

As for results of the second survey (2016): approximately 60% of the respondents were female and 40% were male. All respondents were over the age of 18 years old. More than 82% of the respondents were under the age of 51. As for the economic status, more than 58% were employees, approximately 20% were students. More than 67% of respondents lived in the cities.

Table 2. The results from our two researches (2015, 2016).

Dimension	Items	Mode IKEA I	Mode IKEA II	Mode Möbelix I	Mode Möbelix II	Mean IKEA I	Mean IKEA II	Mean Möbelix I	Mean Möbelix II
Responsibility	Down to earth	2	2	2	2	2,09	2,00	2,28	2,21
	Stable	1	1	2	2	1,72	1,65	2,1	2,22
	Responsible	1	1	2	2	1,8	1,94	2,3	2,36
Emotionality	Romantic	4	4	4	4	3,13	3,12	3,63	3,47
	Sentimental	2	4	4	4	3,12	3,10	3,58	3,43
Activity	Active	1	1	2	2	1,69	1,76	2,12	2,18
	Dynamic	1	1	2	2	1,95	1,93	2,27	2,43
	Innovative	1	1	2	2	1,72	1,76	2,37	2,46
Aggressiveness	Aggressive	5	5	5	5	3,74	3,85	3,56	3,64
	Bold	2	2	2	2	2,34	2,30	2,58	2,77
Simplicity	Ordinary	4	4	2	2	3,17	3,16	2,47	2,43
	Simple	2	2	2	2	2,21	2,15	2,29	2,32

Figure 1 and 2 graphically illustrate the profiles of the brand personalities – dimensions of the IKEA and Möbelix.

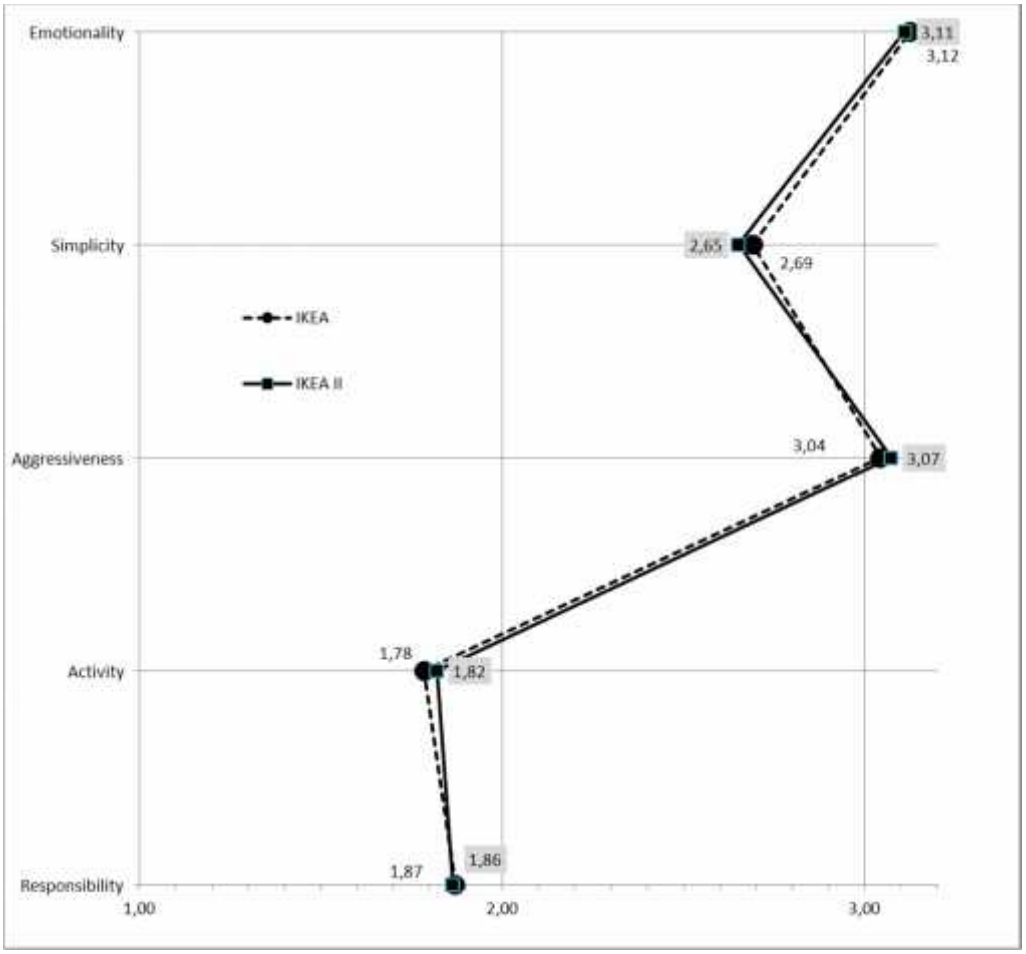


Figure 1. Two profiles of the IKEA – IKEA results from 2015, IKEA II results from 2016

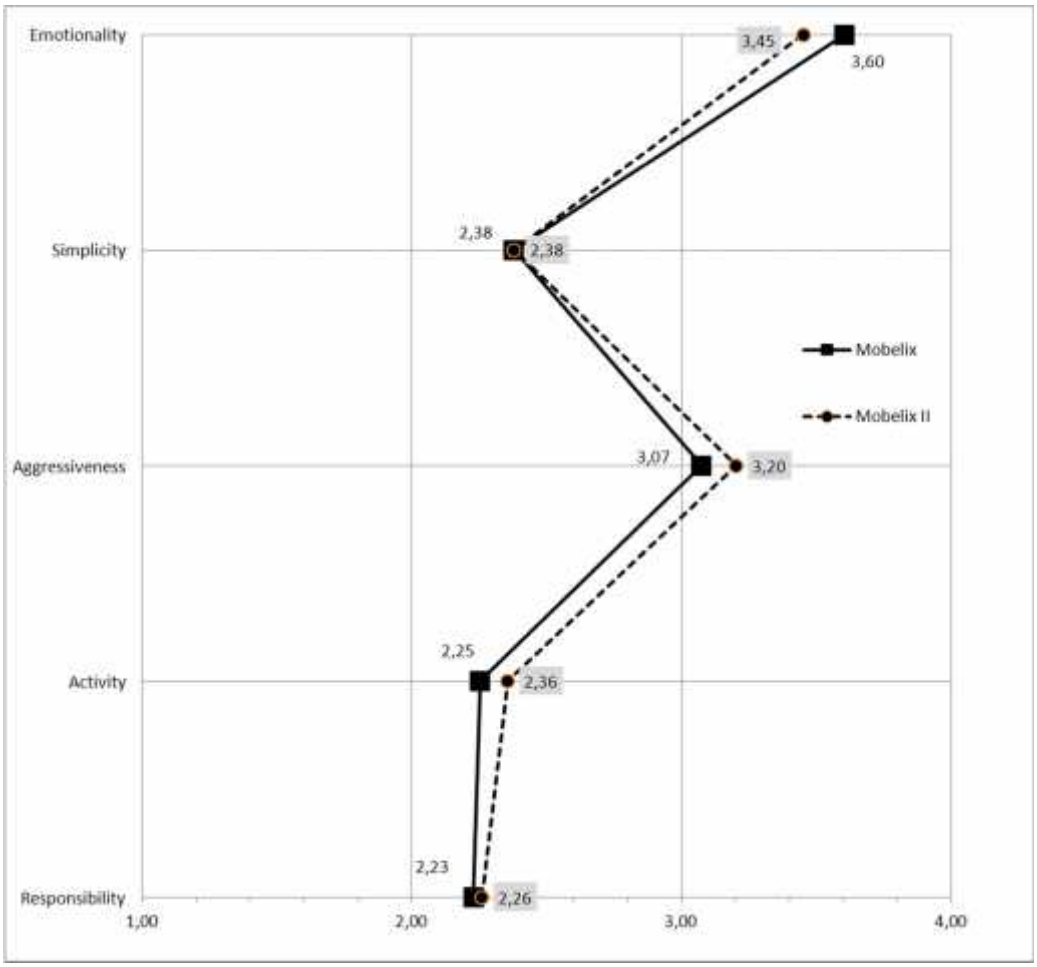


Figure 2. Two profiles of the Möbelix – Möbelix results from 2015, Möbelix II results from 2016

3. DISCUSION

Looking at the profile of IKEA (figure 1, IKEA 2015) it is obvious that this company scored highly on the dimensions of Responsibility and Activity. IKEA is seen as stable and responsible (score at 1.72 and 1.8), Möbelix (figure 2, Möbelix 2015) scored, as for item Stable at 2.10 and Responsibility 2.3. These scores are very close to point 2 – somewhat agree. Based on the scoring in the dimension Activity, IKEA is seen as active (1.69 this score is the lowest one), innovative and a bit dynamic than Möbelix.

As for dimension Aggressiveness, IKEA is seen as bold but not so aggressive, Möbelix scored at 3.56 on this item. IKEA is seen by respondents as bold (2.34). Möbelix scored at 2.58 that is close to midpoint of the scale (neither agree or disagree). The dimension with the highest score is Emotionality for both companies in 2015. The items from this dimension for IKEA have scores at 3.13 – romantic (mode is 4) and at 3.12 – sentimental (mode is 2). Möbelix scored at 3.58 (mode is 4) as for item sentimental. Therefore we can assume that our respondents perceive Möbelix as neither romantic nor sentimental but IKEA is perceive as sentimental but not romantic.

The dimension Simplicity: These results indicate that IKEA is not perceived as much ordinary as Möbelix.

In general as for result from survey conducted in 2015: Möbelix scores higher than IKEA on every dimension except dimension Simplicity and there is a high level of visual similarity between the profiles of both companies.

As for results from research study conducted in 2016 – profiles for Möbelix are quite similar. Small difference we can see in dimensions: Aggressiveness and Activity. The modes for Möbelix (comparing the 2015 and 2016, table 2) there is no difference.

The results for IKEA are very similar, there are small differences in profiles (see figure 1) and there is no difference between modes (see table 2).

3. CONCLUSION

The main aim of this paper is to reveal the brand personality profiles of IKEA and Möbelix using the new measure of the brand personality (NMBP) during 2016 and to compare them to the results of previously research study from 2015

The final results suggest that IKEA is mostly seen as active, stable, innovative, responsible and dynamic but not aggressive and ordinary; Möbelix is more or less seen as stable, active, dynamic, down to earth, simple, responsible but not sentimental and romantic.

We can say that there is very small difference among results of our two independent studies. IKEA has a strong position in the Slovak market and Möbelix (discount seller) has one strong competitive advantage based on low prices.

As for future research, we decided to carry out a deeper analysis of the obtained data.

Acknowledgements: The authors would like to thank the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences. This paper was elaborated within the frame of Grant project 1/0756/16 “Identification of consumers’ segments according to their affinity for environmental marketing strategies of business entities in Slovakia.

REFERENCES

1. Aaker, J. L. (1997). Dimensions of brand personality. Journal of marketing research, 347-356.
2. Bosnjak, M., Bochmann, V., & Hufschmidt, T. (2007). Dimensions of brand personality attributions: a person-centric aproach in the German cultural context. Social Behavior and Personality: an international journal, 35(3), 303-316.
3. Davies, G., Chun, R., da Silva, R. V., & Roper, S. (2001). The personification metaphor as a measurement approach for corporate reputation. Corporate Reputation Review, 4(2), 113-127.
4. Davies, G., Chun, R., da Silva, R. V., & Roper, S. (2004). A corporate character scale to assess employee and customer views of organization reputation.Corporate Reputation Review, 7(2), 125-146.
5. Geuens, M., Weijters, B., & De Wulf, K. (2009). A new measure of brand personality. International Journal of Research in Marketing, 26(2), 97-107.
6. Haji, I., Evanschitzky, H., Combe, I., & Farrell, A. (2012). The forgotten brand personality dimension. NA-Advances in Consumer Research Volume 40.
7. Kaputa, V., Paluš, H., & Vlosky, R. (2016). Barriers for wood processing companies to enter foreign markets: a case study in Slovakia. European Journal of Wood and Wood Products, 74(1), 109-122.
8. Loucanová, E., Parobek, J., & Palus, H. (2014). Identifikácia poziadaviek slovenských zákazníkov na úložný nábytok na základe modelu kano/identification of slovak customers'requirements for storage furniture based on the kano model. Acta Facultatis Xylologiae Zvolen res Publica Slovaca,56(1), 109.
9. Milas, G., & Mlačić, B. (2007). Brand personality and human personality: Findings from ratings of familiar Croatian brands. Journal of Business Research,60(6), 620-626.
10. Parobek, J., Loučanová, E., Kalamárová, M., Šupín, M., & Štofková, K. R. (2015). Customer Window Quadrant as a Tool for Tracking Customer Satisfaction on the Furniture Market. Procedia Economics and Finance, 34, 493-499.
11. Whelan, S., & Davies, G. (2007). A comparative study of the corporate reputation of Irish versus British retailers: lessons for retail brand practice. Irish Marketing Review, 19(1/2), 37.

Authors address:
Maťová, Hana*[1]; Triznová, Miroslava[1]; Dzian, Michal[1]
[1] Department of Marketing, Trade and World Forestry, Faculty of Wood Sciences and Technology, Technical University in Zvolen, Slovak republic
*Corresponding author: matova@tuzvo.sk

INTERMUNICIPAL AND INTERSECTORAL COOPERATION AS A TOOL OF SUPPORTING LOCAL ECONOMIC DEVELOPMENT: SELECTED EXAMPLES FROM THE FOREST AND WOOD-BASED SECTOR IN POLAND

Chudobiecki, J.; Potkański, T.; Wanat, L.

ABSTRACT

Intermunicipal and intersectoral cooperation are still underdeveloped spheres of public and economic development policies. Academic discussions are invariably focused on pro-competitive activities, the economic efficiency of which is not always sufficient. In this paper the authors attempt to identify factors leading to cooperation between local government authorities and economic entities, focusing on examples from the forest and wood-based sector in Poland. These processes are analysed in the framework of the New Institutional Economy, both in the theoretical and practical context.
Key words: intermunicipal cooperation, intersectoral cooperation, partnership, new institutional economy, wood-based sector, Poland.

1. INTRODUCTION

Due to changes in the shaping of local and regional development, which are taking place in Europe and around the world, institutional and economic relationships between the entities creating them are being verified. This refers to intermunicipal relationships, provided we are dealing with such a model of local community organisation, as well as to intersectoral connections to the same extent. Most importantly, phenomena linked with the penetration of individual functional areas and economic sectors are evolving. These borders, still marked mainly by territorial conditions, are not subject to typical limitations any more, irrespective of the scale of the phenomenon. The greater the influence of a selected sector of the economy or entity/institution on the development of a specific territory, the greater the force of impact of these relationships. Certainly, an impact of characteristic factors on the intensity of developmental processes is noticed, including:

- cultural changes (including needs and expectations of inhabitants);
- changes in competitive situation (social and economic);
- innovativeness and development of new technologies;
- changes of local competitive potential (self-governments, entrepreneurs, households).

Such a set of factors referring to local development challenges seems insufficient. Obviously, competitiveness of a local economy, availability and attractiveness of services (social, technical, etc.) for inhabitants of cities and municipalities, and most of all human potential, still decide about development. Simultaneously, development barriers exist which – to a different extent – determine the functioning of municipalities, administrative districts (powiats[20]) or sub-regions in conjunction with the economic activity of enterprises and the everyday life of their inhabitants. Indicating limited amounts of resources, the need for seeking new and dynamic factors is perceived as a starting point in local development programming. Their potential source may constitute an adequate model of intermunicipal and intersectoral cooperation. A development policy based only on competition is no longer sufficient and often leads to opposite effects to those intended.

The authors of this paper made an attempt to verify a hypothesis which assumes an advantage of development factors built on the basis of cooperation models, and not only resulting from the requirements of competitiveness. Based on own research studies, case studies and a descriptive analysis, an analysis of local development was made with reference to a specific sector of the economy

[20] The term “powiat" (in Polish) is most often translated as "county" (into English).

in Poland, i.e. the forest and wood-based sector. Selected factors of cooperation between local authorities and economic entities for the benefit of territorial development were examined in this context. The selection was made on the basis of Poland's economic development and the importance of the wood-based sector[21] for the economy.

2. THE IMPORTANCE OF THE FOREST AND WOOD-BASED SECTOR FOR REGIONAL DEVELOPMENT IN POLAND

When analysing the importance of the forest and wood-based sector, it is appropriate to firstly consider the role of forest resources. Forests cover more than 4 billion hectares of the total surface area of the world, which means approximately 0.6 ha of forests per capita. The surface area of forests in Poland totals 9.3 million hectares – 0.23% of the global surface area of forests (55th place) and 6% of the surface area of forests in Europe (10th place). The forest ratio in Poland (in relation to its land surface area) is 29.3%. This value is close to the average forest ratio in the world (29.6%) and to the forest ratio in Europe, which is 30.3% (excluding Russia). Moreover, standing timber resources in Poland constitute 9.5% (2.3 billion cubic metres) of all forest resources in the European Union (4th place in EU) [GUS Leśnictwo 2015].

The Polish wood industry plays an important role for the development of the economy. The most important sectors based on wood include: sawmill industry, furniture industry, cellulose and paper industry, market of wood-based panels. This industry is highly fragmented and focuses on small and medium-size businesses (there are only a few large enterprises). A significant number of micro-enterprises (covering approx. 30% of the entire sector) are not included in any official statistics. The share of the wood-based industry in the production of the entire Polish processing industry is more than 9%. The wood industry processes more than 37 million cubic metres of round timber on average per year, purchased mainly from National Forest Holding "State Forests" (Państwowe Gospodarstwo Leśne Lasy Państwowe) and worth more than PLN 7 billion[22]. The potential of the wood industry is additionally confirmed by the level of employment – more than 260 000 employees (including 124 000 in the furniture industry and 49 000 in the paper industry). The production value in the wood-based sectors exceeds PLN 90 billion (including PLN 32 billion in the paper industry and PLN 28.3 billion in the furniture industry); the upwards trend is maintained. The value of export of wood industry products in Poland totals more than EUR[23] 15 billion with an upwards trend. Export of furniture dominates and reaches the value of PLN 6.7 billion. Poland is the fourth largest exporter of furniture in the world (following China, Italy and Germany), while other EU countries are the main recipient of Polish furniture (more than 80% of export value) [GUS Leśnictwo 2015].

The competitive position of the Polish wood-based sectors is relatively strong. It is an effect of forest resources, the quantity and quality of round timber acquired from the national resource base, as well as continually growing significance of wood-based products in global production and trade. Despite the imbalance in the Polish wood market and the deficit of the wood raw material (a permanent phenomenon being an effect of the application of the principles of sustainable forest management), there is no threat

[21] The forest- and wood-based industry belongs to special sectors of the economy. Problems of the economic, environmental and industrial nature coexist within its boundaries. It may seem obvious, because the concept of "sustainable development" comes directly from forestry. The author of this concept (Hans Carl von Carlowitz), defined as such the concept of forest economy which consists in obtaining only the amount of industrial wood that can be recreated based on natural renewal (thus creating a new chapter in economic sciences [Mantel 1973, Wanat 2009]). Additionally, the traditional model of the economy is questioned increasingly more often. A need has been identified to seek new paths of economic growth based on the concept of the so-called green road to development [Chudobiecki and Wanat 2015].

[22] For comparison, the current average exchange rate is 1 USD = 3.9164 PLN [source: http://www.nbp.pl/homen.aspx?f=/kursy/ratesa.html – accessed 2.09.2016].

[23] For comparison, the current average exchange rate is 1 EUR = 4,3796 PLN (source: http://www.nbp.pl/homen.aspx?f=/kursy/ratesa.html - accessed 2.09.2016].

for the development of wood-based industries in Poland. The following factors have a decisive impact on that: dynamic increase of demand for wood, fashion for wood and popularity of wood as an environmentally and human friendly raw material [Kaputa, Paluš and Vlosky 2016]. A study of intersectoral and intermunicipal relationships – as potential factors of development – seems justified with reference to the wood-based sector, especially owing to its territorial dispersion.

3. DILEMMAS OF INTERMUNICIPAL AND INTERSECTORAL COOPERATION FOR THE BENEFIT OF DEVELOPMENT

Successive exhausting of resources which were the basis of local and regional development in Poland after 1989 is observed [Szewczuk 2016]. These resources include: income generated by traditional sectors of economic activity, free land and facilities, unused human resources. Revenues from sale of property in the conditions of relative short-term economic prospects, European Union funding and credits (i.e. one-time or short-term income) have been used to finance local development so far. At the same time, the scope of tasks of regional and local authorities has increased; changes resulting from globalisation processes are taking place in the economy; local communities are getting older and population numbers are actually going down. Demographic changes result from a drop in the birth rate and unfavourable migration tendencies. At the same time, they are the cause and effect of cultural, systemic and structural changes in the economy. It seems that in the face of challenges associated with globalisation and glocalisation[24], a human being (human capital) who does not want to be dependent on competition law only becomes the key factor of development[25] [Słodowa-Hełpa 2015].

Functioning in changing conditions requires integration and improvement of the system of territorial development management by local authorities. Based on analyses conducted so far, monitoring and evaluation of changes taking places inside local communities and in functional areas are considered the starting point [Wanat and Potkański 2011]. This mainly includes:

- assessment of municipality's potential within the scope of its own functional area;
- redefinition of the role of a municipality within its own functional area;
- permanent adjustment of infrastructure, economy and services in a given functional area to dynamically changing needs.

At least some local development barriers have been identified in this context:

- a change of a traditional economy model to a knowledge-based economy;
- outflow (internal migration) of the most talented inhabitants to other cities and regions;
- urban sprawl and escape of inhabitants of city centres to suburban areas[26];
- a necessity for permanent education and constant adjustment of employees' potential to structural changes and expectations of the labour market;
- a growing level of social inequalities, being a result of technological, economic and cultural exclusion in local communities;
- a limited offer of local services (based on infrastructure rather than social resources) with a dropping impact on the quality of life of inhabitants;
- a relatively low level of collaboration between local authorities, social partners and entrepreneurs in the local and regional dimension.

[24] Glocalisation "expresses the way globalisation dynamics - are always reinterpreted locally, leading to an interpenetration of the local and global scales that created context- dependent outcomes". Some authors [Robertson 1992, Swyngedouw 1997, Backhaus 2003; Słodowa-Hełpa 2015] go so far "as to consider that glocalisation in the way that globalisation really operates". Like the other "dynamics of globalisation, glocalisation also takes place in different fields" (first of all, in the field of culture and economics) [source: http://www.glopp.ch/A4/en/multimedia/glocalisation.pdf - accessed 2.09.2016].

[25] See the research work in the field "The Interdisciplinary Nature of the New Paradigm of Development - Considerations and Proposals for Improving the Dialogue…" [Swyngedouw 2004, Słodowa-Hełpa 2015].

[26] The case of big cities.

It is worth comparing the indicated barriers with a thesis formulated by Richard Florida, the author of "Who is your city?", who tries to convince that the possibilities of local development are influenced to a large extent by an ability to attract young inhabitants. Cities and regions that attract young people win the competition with other cities for a better future. The winning places are the ones that become appealing for the youth [Florida 2010]. Actually, research studies confirm that sudden and rapid development is observed in places where young people migrate and settle. This view, in conjunction with the results of studies in local self-governments, leads to an interesting conclusion, i.e. local development will probably be determined by creative economy, in particular the force of combining the quality of an offer for young people with the level of intersectoral cooperation in functional areas. With reference to sectors of the economy, including the wood-based sector, challenges in terms of building intersectoral cooperation have been identified in three main areas [Wanat and Lis 2009]:

- establishing and developing small and medium-size businesses;
- research and creative economy (innovations);
- efficient energy and use of renewable energy sources.

In the light of various observations it is required to improve the effectiveness of providing public services in collaboration with partners (process innovations) and using modern technologies (product innovations). It is extremely difficult to work out and implement an effective development policy without being oriented on cooperation, coopetition and constant exchange of experiences between partners from various sectors.

4. ASSESSMENT OF THE CONDITIONS OF INTERMUNICIPAL AND INTERSECTORAL COOPERATION IN POLAND

Each settlement unit (e.g. a municipality) is a part of a specific functional area. Therefore, the addressee of the development policy should not be only an administrative unit, but a functional area which may create many administrative units, and entities operating within a given territory. It is hard to imagine development of functional areas without the support of partnership tools. There are no comprehensive regulations in Polish law which would organise the matter of cooperation between local government units, both in the intermunicipal and intersectoral aspects.

Naturally, several so-called institutional forms of cooperation with the participation of local government units have been identified. They include: unions of local government units, metropolitan unions, agreements of local government units, associations with the participation of local government units (including local action groups) and commercial companies with the participation of local government units. Cooperation may also be established under public-private partnerships in case of single projects. Other forms of cooperation are regulated by contractual freedom under civil law; they are the basis for the following: consortia, clusters, agreements on mutual cooperation and exchange of experiences. Their application, however, is characterised by limited coverage, mainly due to institutional barriers. The Polish legal system does specify a universal formula of institutional cooperation. The differences in functioning structures are linked among others with:

- partnership composition and mode of partner selection;
- objectives of partnership operations;
- scope of obligations and responsibilities;
- methods of financing;
- flexibility in the shaping of cooperation rules.

Legal provisions determine to a large extent the Polish model of intermunicipal and intersectoral institutional cooperation [Potkański 2016].

4.1. The "model of cooperation" – paradigm of partnership

A new proposal of a cooperation model is a result of research studies regarding various factors of intermunicipal and intersectoral cooperation. The model describes a desired target set of mechanisms of cooperation in key aspects of a partnership's functioning. These aspects, in the form of scenarios enabling evaluation of partnership quality, have been presented as 10 standards of institutional cooperation. Seven standards refer to strategic management of territorial development, while the remaining three are associated with operational management of relationships within a partnership. An integral partnership requires a combination of aspects of the strategic, operational and uniform development of the 10 areas, determined by the "canons" of cooperation model standards (see: Table1).

Table 1. The 10 areas determined by the "canons" of intersectoral cooperation model standards

THE "CANONS" OF COOPERATION MODEL STANDARDS		
Strategic dimension (strategic management in a partnership)		
I.	Partnership composition (a team adjusted to cooperation objectives)	Objective-oriented cooperation of entities from 3 sectors (public, social and economic)
II.	Partnership's potential (a diagnosis of resources and developmental needs of a functional area)	A constant diagnosis of a functional area and identification of development factors are the foundation of cooperation
III.	A network of functional connections	The potential of functional connections in the scope of public services and market activity on the territory of a partnership
IV.	Development programming (sectoral strategies and programmes)	Implementation of strategies and programmes of functional area development
V.	Integration of services and infrastructure (coordination of resources and public services)	The level of infrastructure and service integration within a functional area is considered the measure of development
VI.	Integration and operationalisation of development strategies (for a partnership and for partners)	The compliance of strategic and operational documents of all partners with development priorities
VII.	Monitoring and evaluation	Permanent assessment of partnership's performance and effectiveness
Operational dimension (management of relationships in a partnership)		
VIII.	External relationships	Partnership's communication with inhabitants and other stakeholders is a tool enabling to build social trust
IX.	Space for debate and internal communication	Professionalism and transparency of debate as well as quality of dialogue in a partnership are considered criteria of cooperation development
X.	Mutual trust	Relationships in a partnership are based on: mutual trust, equal treatment and just distribution of responsibilities between all "actors"
THE AGGREGATE DEVELOPMENT INDEX (ADI_{LGU})[27]		

Source: own elaboration based on [Potkański 2016, pp. 127-163, http://zpp.pl/sites/default/files/aktualnosci/publikacja_wspolpraca_jst_ok.pdf#page=127, accessed: 21.08.2016].

The "model of cooperation" determined by the ten standards is complemented by two evolutionary postulates. They include a competitiveness diagnosis and an analysis of functional connections in

[27] A model was created Aggregate Development Index (for local government units {LGU}) [Potkański 2016].

a partnership. One of the measures supporting the process of evaluation is the so-called Aggregate Development Index [Potkański 2016, pp. 36-42].

4.2. The Aggregate Development Index

A model was created Aggregate Development Index (for local government units {LGU}), which can be presented in the following manner:

$$ADI_{LGU} = f(Q)\ \{Q_1; Q_2; Q_3; Q_4; Q_5; Q_6; Q_7; \ldots Q_n\}$$

Individual symbols mean:
ADI_{LGU} – Aggregate Development Index (based on the model);
Q_1 – Wealth of inhabitants;
Q_2 – Level of economic activity;
Q_3 – Infrastructural space productivity;
Q_4 – Local real estate market potential;
Q_5 – Demographic potential;
Q_6 – Level of social development (the most - destimulant);
Q_7 – Demographic burden (the most – destimulant);
Q_n – Additional measures (the most – specific determinants).

The value of the Index is composed of at least 7 main elements, which reflect individual components of a municipality's potential (functional area). These include: (1) wealth of inhabitants (PIT per capita), (2) level of economic activity (CIT per capita), (3) infrastructural space productivity, (4) local real estate market potential, (5) demographic potential (the so-called Creativity Index by Richard Florida) – as stimulants, and (6) level of social development (unemployment) and (7) demographic burden – as destimulants. The catalogue of components is an open set, permanently infinite, dependant on the individual features of a functional area.

The value of the Aggregate Development Index was calculated as a sum of standard deviations for particular components. The components were not given any measures to make the process simpler. The "Z-scores" method was applied, which enabled to determine the aggregate value of the index as a sum of standardised values of partial components [Potkański 2016, pp. 40-42]. Selected results were illustrated in a table and graphically (see: Table 2 and Figure 1).

Table 2. Changes to the Aggregate Development Index ADI_{LGU} value in the years 2008-2014

ADI_{LGU} changes in the years 2008-2014 in Poland					
LGU (municipalities)	Drop ADI	Growth ADI	TRENDS	Change ADI	Number municipalities
Big cities (powiat)	60 (91%)	6 (9%)		More than 5 points ↓ <-13;-5>	47
Municipalities (other)	188 (79%)	50 (21%)		Less than 5 points ↓ <-5; 0>	1105
Urban-rural municipalities	307 (50%)	304 (50%)		Less than 5 points ↑ <0; +5>	1315
Rural municipalities	597 (38%)	967 (62%)		More than 5 points ↑ <+5; +28>	12
Selected intersectoral partnerships in the forest- and wood-based sector[28]		↑ 58%			2479 (100% LGU/municipalities in Poland [2014])

[28] The Index value estimated statistically - representative sample - of partnerships in the forest and wood-based sector, working in 5 regions: Opole, Szczecin, Zielona Gora, Koszalin and Olsztyn [Wanat 2016]. The formulated sub-model - for the forest and wood-based sector - explains 58% of the variability of predictor $\hat{Y}$ (endogenous variable), which is the value of the Aggregate Development Index ADI_{LGU} (confidence level 90%, fraction size 0.5, and maximum error of estimate 10%). There was a trend similar to that for all municipalities (rural) [Graczyk 2005, Pokusa 2011, Lis 2012, Wanat 2016].

Source: own elaboration based on [Potkański 2016, pp. 40-42, http://zpp.pl/sites/default/files/aktualnosci/publikacja_wspolpraca_jst_ok.pdf#page=41, accessed: 21.08.2016].

4.3. The growth potential map of intersectoral partnerships in Poland

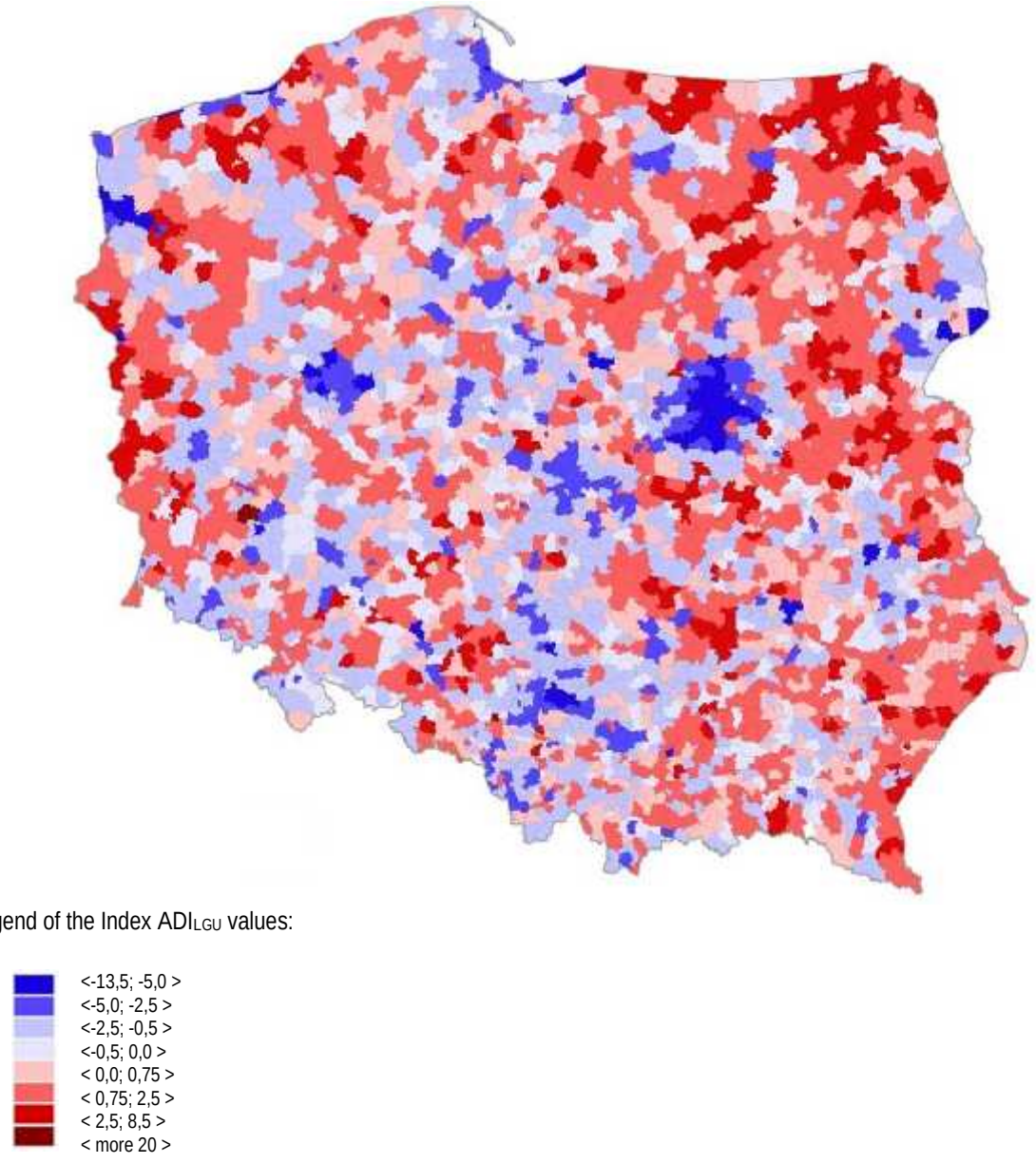


Figure 1. The variation of the value of the Aggregate Development Index municipalities in Poland (difference 2008-2014)

Source: [Potkański 2016, p. 41, based on: Porawski A., Potkański T., Czajkowski J.M., Szewczuk J., Ogólna charakterystyka stanu i uwarunkowań współpracy jednostek samorządu, http://zpp.pl/sites/default/files/aktualnosci/publikacja_wspolpraca_jst_ok.pdf#page=41, accessed: 21.08.2016]

In the examined period from 2008 to 2014, a drop in the Aggregate Development Index was observed in general for 1152 municipalities (the drop was significant in case of 47), while an increase of the Index value was identified for 1327 municipalities (including a significant increase in case of 12). This increase refers mainly to rural municipalities. No significant change was observed for urban-rural

municipalities. Meanwhile, a substantial drop of the Index value was observed for towns and cities (including mainly 60 towns and cities with powiat rights). Moreover, a relatively constant level of the PIT per capita component was observed, with a simultaneous significant rise of the total dependency ratio (demographic burden) [Potkański 2016, pp. 40-42].

Selected examples of intersectoral partnerships, co-established by entities from the forest and wood-based sector, were selected from a multiple case study and included in a comparative analysis. In places where an intersectoral partnership was functioning effectively, a significant increase of the Aggregate Development Index for a given functional area was observed in the analysed period. Moreover, shifting tax "productivity" from cities to neighbouring areas, including suburbs (local migration and urban sprawl), constitutes an argument in favour of intersectoral cooperation development.

5. CONCLUSIONS

The following conclusions were formulated:

1) Investigating the potential and development capabilities of functional areas is of essential importance for the economic development of regions, especially for industries characterised by high territorial fragmentation, e.g. the forest and wood-based sector in Poland.

2) An analysis of changes in the Aggregate Development Index values makes it possible to identify the functional areas and municipalities which have a capacity to establish intersectoral partnerships. Comparing the map of spatial diversity of the Aggregate Development Index with the map of forest resources potential and the location of entities from the forest and wood-based sector makes it possible to indicate additional criteria for the development of intersectoral partnerships with the participation of forest management.

3) Institutional conditions of intermunicipal and intersectoral cooperation in Poland are concurrently an opportunity and a barrier for the establishment of partnerships with the participation of the forest and wood-based sector. The model based on the "canons" of cooperation quality assessment standards may be a tool enabling to evaluate opportunities for the development of intersectoral partnerships of an institutional character.

4) Structural similarities of partnerships established by local government units and the forest and wood-based sector in Poland result from the conditions of the economic policy and public policies. They are determined by the natural monopoly of State Forests (Państwowe Gospodarstwo Leśne Lasy Państwowe) as well as the high degree of institutionalisation of the wood market in Poland (primary market). The functioning of a secondary market in the forest and wood-based sector, dispersed and territorially diversified, is subject to market mechanisms. However, due to the dependence on wood resources, local wood markets are determined by the impact of the primary market of an institutional character.

A research approach, applied in this paper, to the examination of the development of intermunicipal institutional partnerships may constitute a starting point for a study regarding intersectoral cooperation. The analysis of selected examples from the forest and wood-based sector in Poland shows that the dynamics of integrated development of functional areas are determined by collaboration between and combination of the potential of different, both institutional (public) and market, entities.

Acknowledgements: This paper was prepared within the project "Scholarship support for PH.D. students specializing in majors strategic for Wielkopolska's development", Sub-measure 8.2.2 Human Capital Operational Programme, co-financed by European Union under the European Social Fund.

REFERENCES

1. Backhaus N. (2003): Zugänge zur Globalisierung. Konzepte, Prozesse, Visionen. Schriftenreihe Anthropogeographie 17. Zürich, Geographisches Institut Universität Zürich.
2. Chudobiecki J., Wanat L. (2015): Industrial Symbiosis and Green Business Parks in The Wood-Based Sector in Poland [in:] Wood Processing and Furniture Manufacturing Challenges on the World Market, WoodEMA, i.a. – International Association for Economics and Management in Wood Processing and Furniture Manufacturing, Zagreb, Croatia, pp. 221-228.
3. Florida R. (2010): Who's Your City?: How the Creative Economy is Making Where to Live the Most Important Decision of Your Life. Vintage Canada.
4. Graczyk A. (2005): Lasy oraz gospodarka leśna w strategii wzrostu gospodarczego i rozwoju zrównoważonym [in:] Święcicki Z.Ś. (eds.) Polskie lasy i leśnictwo w Europie, Centrum Informacyjne Lasów Państwowych, pp. 85-86.
5. GUS Leśnictwo (2015): Forestry. Central Statistical Office. Warszawa. Publication available on the Internet [http://stat.gov.pl/files/gfx/portalinformacyjny/pl/defaultaktualnosci/5510/1/11/1/lesnictwo.pdf accessed: 21.08.2016].
6. Mantel K. (1973): Holzmarktlehre. Ein Lehr- Und Handbuch der Holzmarktökonomie und Holzwirtschafts-politik, Melsungen, Berlin, Basel und Wien.
7. Kaputa V., Paluš H., Vlosky R. (2016): Barriers for Wood Processing Companies to Enter Foreign Markets: a Case Study in Slovakia. European Journal of Wood and Wood Products, 74(1), 109-122.
8. Lis W. (2012): Grupowanie odbiorców drewna okrągłego z Lasów Państwowych, Rynek Drzewny, (3), 9-11.
9. Robertson R. (1992): Globalization - Social Theory and Global Culture. Sage Publications, London.
10. Słodowa-Hełpa M. (2015): Interdyscyplinarna natura paradygmatu rozwoju – uwarunkowania i propozycje usprawnienia dialogu. Nierówności społeczne a wzrost gospodarczy, (41), 67-92.
11. Swyngedouw E. (1997): Neither Global nor Local: "Glocalization" and the Politics of Scale [in:] Kevin R. Cox (ed.). Spaces of globalization, reasserting the power of the local. New York, London, The Guilford Press: 137-166.
12. Swyngedouw E. (2004): Globalisation or "Glocalisation"? Networks, Territories and Rescaling. Cambridge Review of International Affairs, 17(1), 25-48.
13. Pokusa T. (2011): Klaster drzewny, klaster energii odnawialnych, klaster chemiczny. Możliwości funkcjonowania i rozwoju klastra rekreacyjno-ruchowego w województwie opolskim, Wyższa Szkoła Zarządzania i Administracji, Opole.
14. Potkański T. (2016): (eds.) Współpraca jednostek samorządu terytorialnego narzędziem wsparcia polskiej polityki rozwoju, Związek Miast Polskich, Poznań.
15. Szewczuk J. (2016): Przed jakimi wyzwaniami stoją samorządy i dlaczego muszą współpracować [in:] Potkański T. (2016) (eds.) Współpraca jednostek samorządu terytorialnego narzędziem wsparcia polskiej polityki rozwoju, Związek Miast Polskich, Poznań , pp. 13-25.
16. Wanat L. (2009): Wood Market Science a New Discipline of Economic Sciences Supporting Knowlege-Based Economy Development. Intercathedra, 25, pp. 149-151.
17. Wanat L. (2016): Dobre praktyki współpracy międzysamorządowej [in:] Potkański T. (2016) (eds.) Współpraca jednostek samorządu terytorialnego narzędziem wsparcia polskiej polityki rozwoju, Związek Miast Polskich, Poznań, pp. 141-163.
18. Wanat L., Lis W. (2009): Promotion of Best Practices - Project Proposal for the Wood Industry in Poland. Intercathedra, 25, pp. 151-155.
19. Wanat L., Potkański, T. (2011): Barriers for Effective Regional Leadership in Time of Crisis. Intercathedra, 4(27), 75-79.

Authors address:
Chudobiecki[1], Jan; Potkański[2], Tomasz; Wanat*[3], Leszek;
[1] Department of Economics and Wood Industry Management,, Poznan University of Life Sciences, Poznań, Poland;
[2] Institute of Public Policies, Collegium Civitas in Warsaw, Warszawa, Poland;
[3] Faculty of Economics and Social Sciences, Poznan University of Life Sciences, Poznań, Poland;
* Corresponding author: leszek.wanat@up.poznan.pl

FUNCTION AND USE OF PEFC C-O-C CERTIFICATION IN THE EU TIMBER REGULATION SYSTEM OF DUE DILIGENCE

Dudík, R.

ABSTRACT

The paper presents basic results of created methodology related to the EU Timber Regulation (EUTR). The methodology brings the PEFC C-o-C system into line with the requirements of EUTR legal regulations according to TD CFCS 2002:2013. The starting point consists in differences identified between the requirements of EUTR legal regulations imposed on operators and the requirements of TD CFCS 2002:2013 standard. In addition, basic requirements of EUTR legislation are highlighted that are imposed on wood-processing enterprises, which are operators at the same time. Analysed is also the area of imports of selected wood-based products to the Czech Republic from regions, which are problematic for risky imports of controversial sources of raw wood material.
Key words: PEFC, chain of custody, EU timber regulation, controversial sources, operator

1. INTRODUCTION

Pursuant to the Regulation of the European Parliament and of the Council No 995/2010, due diligence systems represent one of tools employed to minimize the risk of placing illegally harvested timber or products derived from such timber on the market of the European Union. During the last several years, one of key issues discussed by international forest forums has been how to prevent the merchandise of illegally harvested timber and products derived from such timber (Dudík, Šišák 2014).

On the other hand, to determine the contents of the concept "illegal timber harvesting" is not an easy task as mentioned by Dudík, Šišák (2014). Discussions are led worldwide about what exactly can be considered illegal. Here we should point out that an internationally recognized definition of illegal timber harvesting does not exist. What is taken for legal in Vietnam may not be legal in Indonesia and vice versa. According to literature, illegal timber harvesting generally occurs if timber is felled, transported, sold or purchased in contravention with the national law (Heeswijk 2010). Unfortunately, activities that are considered illegal greatly differ in various sources. Some authors even differentiate illegal timber harvesting and illegal forest activities. According to them, illegal timber harvesting is a part of these activities, which also include illegal activities occurring during transport, illegal processing and export, wrong customs clearance or tax avoidance (Guertin 2003). Illegal timber harvesting is generally quite common in most countries that are main timber producers (China, India, Canada, Indonesia and Brazil). The extent of illegal timber harvesting in some countries is so large, and the enforcement of law so poor, that detection and punishment are virtually impossible. It is generally estimated that up to ¾ of the tropical timber and up to ½ of the timber for industrial purposes have to do with at least one illegal activity. Particularly problematic regions are the Amazon River Basin, Central Africa, Southeast Asia and Russian Federation (Brack 2006). Thus, countries in these regions can be considered risky in terms of placing on the market illegally harvested timber and products derived from such timber.

The whole issue resolving the placement of timber and timber products on the market (commonly used is also a EUTR acronym – for EU Timber Regulation) stems from a concept of the European Union, which is projected in the following three principal regulations:

- Regulation (EU) No 995/2010 of the European Parliament and of the Council laying down the obligations of operators who place timber and timber products on the market – hereinafter "Timber Regulation" (EU 2010).

- Commission Delegated Regulation (EU) No 363/2012 on the procedural rules for the recognition and withdrawal of recognition of monitoring organizations – hereinafter "Regulation (EU) No 363/2012" (Commission 2012a).
- Commission Implementing Regulation (EU) No 607/2012 on the detailed rules concerning the due diligence system and the frequency and nature of the checks on monitoring organizations – hereinafter "Regulation (EU) No 607/2012" (Commission 2012b).

2. OBLIGATIONS OF WOOD-PROCESSING ENTERPRISES - OPERATORS

If a forest owner identifies himself as an operator, there are three basic obligations arising for him (Dudík, Šišák 2014):

1. The placing on the market of illegally harvested timber or timber products derived from such timber shall be prohibited (the operator is namely an entity, which places timber and timber products on the internal EU market for the first time).
2. Operators shall exercise due diligence when placing timber or timber products on the market. For this purpose, they shall use a framework of procedures and measures hereinafter referred to as DDS as set out in Article 6 of the Timber Regulation.
3. Each operator shall maintain and regularly evaluate the due diligence system, which he uses, except where the operator makes use of a due diligence system established by a monitoring organization.

The operator has essentially two possibilities how to introduce the due diligence system:

1. The operator will introduce a DDS developed by himself:
   a) The operator shall develop a DDS of its own within the frameworks set out in Article 6 of the Timber Regulation with taking into account the actual situation in which he appears.
   b) The operator shall develop a DDS of his own within the frameworks set out in Article 6 of the Timber Regulation while using other systems covering objectives similar as EUTR (this will largely apply to forest certification systems and systems of the consumer chain of forest products) with taking into account the actual situation in which he appears.
2. The operator shall make use of a due diligence system established by a monitoring organization – as set out in Article 8 of the Timber Regulation.

Thus, responsibility for the functional and maintained DDS is either on the part of the operator (in the case of own establishment) or also on the part of the monitoring organization (in the case of establishing DDS for the operator).

3. FORESTRY CERTIFICATION SYSTEMS

Requirements of forestry certification systems are analysed, in relation to the certified organizations and to the EUTR generally. The comparison of the surveyed requirements clarifies the role of forest certification systems in the EUTR (Dudík, Riedl 2015).

First, it is worth highlighting that the Commission Implementing Regulation (EU) No 607/2012 sets basic terms of use of certification in risk assessment and mitigation. When a forest certification system meets the requirements, it can be used in the framework of EUTR. Besides, forest certification systems in the context of the Czech Republic constitute an independent and separate certification:

- Sustainable Forest Management (SFM) and
- Chain-of-Custody of Forest Based Product (C-o-C).

In 2013, the PEFC International revised its international standard for C-o-C, and consequently, the Czech Republic revised its technical document setting the requirements for C-o-C. A revised C-o-C document TD CFCS 2002:2013 resulted. This technical document contains – apart of standard demands for C-o-C – also minimum requirements for the due diligence system. Actually, if operators apply C-o-C system together with the TD CFCS 2002:2013, they will also, in principle, meet the due diligence system requirements. Nevertheless, operators should take on the responsibility to create a due diligence system customized for their particular circumstances. TD CFCS 2002:2013 standard formulates concrete requirements in defined frameworks, i.e. not the particular circumstances of a particular operator; therefore, it is important to apply a due diligence system in accordance with EUTR European regulations. The above mentioned standard, however, presents a good concept of how the due diligence system might look like (Dudík, Riedl 2015).

EUTR Implementation Rules complements the situation: "Certification of the supply chain can be used as a proof that no non-certified or non-controlled timber enters the supply chain. Generally, it is desirable that only licensed timber enters the supply chain 'at critical check points' and that the timber is traceable to its previous owner (who must also be certified), not only to the forest it was harvested in. A supply-chain-certified product might contain a mix of certified and other licensed materials from various sources. If the certification of the supply chain is used as a proof of legitimate origin, the operator should ensure that all the material is licensed, certified, and its monitoring processes sufficient to eliminate other than the licensed material."

The citation applies to C-o-C certification of any forest certification system. It is obvious – in relation to the explanation above – that it might be cost ineffective for some operators to create an appropriate due diligence system by TD CFCS 2002:2013 – especially in case of our smaller subjects who apply an easy and unambiguous identification of their timber sources. Major subjects with varied sources of timber entering the market might find the creation of a due diligence system (by TD CFCS 2002:2013 standards) a possible way to comply with the Timber Regulation. This conclusion basically corresponds with conclusion of Paluš et al. (2014).

In the conclusions of his study, Dudík (2014) documents the possibility of using the functional established PEFC C-o-C system in organizations for demonstrating the fulfilment of requirements following out from the EUTR legislative regulations. A gap analysis of the PEFC C-o-C standard requirements and the requirements of EUTR legislation revealed that the PEFC C-o-C standard requirements are at a level of the requirements of European legislation nearly in line with the requirements of EUTR legislative regulations. In the case of PEFC C-o-C standard requirements, s space for enhancement is seen in the following areas:

1. An obligation should be introduced for PEFC C-o-C certified organizations for product groups defined by the organizations to include on the input wood and wood-based products, which are at the same time listed in the Annex to the EU Timber Regulation no. 995/2010.
2. An obligation should be introduced for PEFC C-o-C certified organizations to evaluate the risk of acquiring the raw wood material from controversial sources for all input forest-based materials without exception.

With regard to the requirement of risk assessment in the procurement of raw material from controversial sources, it is useful that each organization has an idea about the risks in the context of country or region from which the raw material originates. The information is also important for competent authorities in the individual EU countries.

Competent authorities should monitor that operators effectively fulfil the obligations laid down in this Regulation. For that purpose, the competent authorities should carry out official checks, in accordance with a plan as appropriate, which may include checks on the premises of operators and field audits, and should be able to require operators to take remedial actions where necessary.

The plans of inspections then have to take into account the risks of timber or wood-based products originating from controversial sources being marketed in the given EU country. Here, the analysis of selected imported wood-based products may become a considerable contribution in drafting the plans

of inspections. Volumes of the imports of some products from selected "risk countries" outside EU are presented in the following chapter.

4. RISK OF PLACED ILLEGALLY HARVESTED TIMBER ON THE MARKET IN THE CZECH REPUBLIC

As to the import of raw timber in 2008, it amounted to 1.122 million m^3 of which 1.073 million m^3 originated from the countries of EU-27 (MoA 2009). Here, it is important to bear in mind that the Timber Regulation applies to more products than just to raw timber – see the Annex to the Timber Regulation. The below presented tables and diagram focus products and commodities imported to the Czech Republic in the period from 2005-2013, which are covered by the following codes of the Combined Nomenclature: 4401, 4403, 4406, 4407, 4408, 4409.

Table 1 shows the value of imports of commodities covered by the six above-mentioned codes of the Combined Nomenclature to the Czech Republic in the period from 2005-2013. In the descending order, the table brings a list of countries from which commodities were imported to the Czech Republic at a value exceeding in total 1 million EUR in market prices. It follows out from the table that the highest imports in the studied period were from Russian Federation (117.409 million EUR). Imports closely over 1 million EUR (1.180 million EUR) were from the Central African Republic.

Table 1. Imports to the Czech Republic from selected countries in the period from 2005-2013 in thousands EUR – market prices

ISO country code		Year									Total
		2005	2006	2007	2008	2009	2010	2011	2012	2013	
	Country	thousand EUR									
RU	Russian Federation	14,104	12,229	11,562	13,772	12,731	16,320	15,783	10,847	10,061	117,409
UA	Ukraine	6,020	4,460	6,250	5,271	5,024	9,045	13,601	13,125	14,573	77,369
BY	Republic of Belarus	1,431	492	320	137	497	7,021	9,287	12,637	11,129	42,951
EE	Republic of Estonia	4,855	4,040	2,673	4,512	3,916	4,011	4,302	2,790	2,134	33,233
ID	Republic of Indonesia	4,940	6,222	7,363	3,204	2,587	1,472	2,586	1,837	2,071	32,282
LT	Republic of Lithuania	185	294	476	604	1,698	862	1,194	4,671	4,326	14,310
BR	Federal Republic of Brazil	595	985	1,360	2,180	1,625	1,335	1,118	1,978	1,707	12,883
LV	Republic of Latvia	1,099	523	1,238	1,398	530	770	606	506	709	7,379
CG	Republic of the Congo	502	171	1,085	243	221	940	947	1,041	1,237	6,387
MY	Malaysia	361	469	487	334	350	442	454	317	266	3,480
CD	Democratic Republic of the Congo	75	313	669	574	694	352	413	231	0	3,321
GH	Republic of Ghana	549	769	481	338	144	245	143	23	48	2,740
UZ	Republic of Uzbekistan	302	1,706	0	35	192	103	94	0	0	2,432
CM	Republic of Cameroon	249	112	370	210	245	205	179	284	442	2,296
AM	Republic of Armenia	598	1,010	42	20	0	0	0	0	0	1,670
CF	Central African Republic	19	14	6	0	0	106	681	253	101	1,180

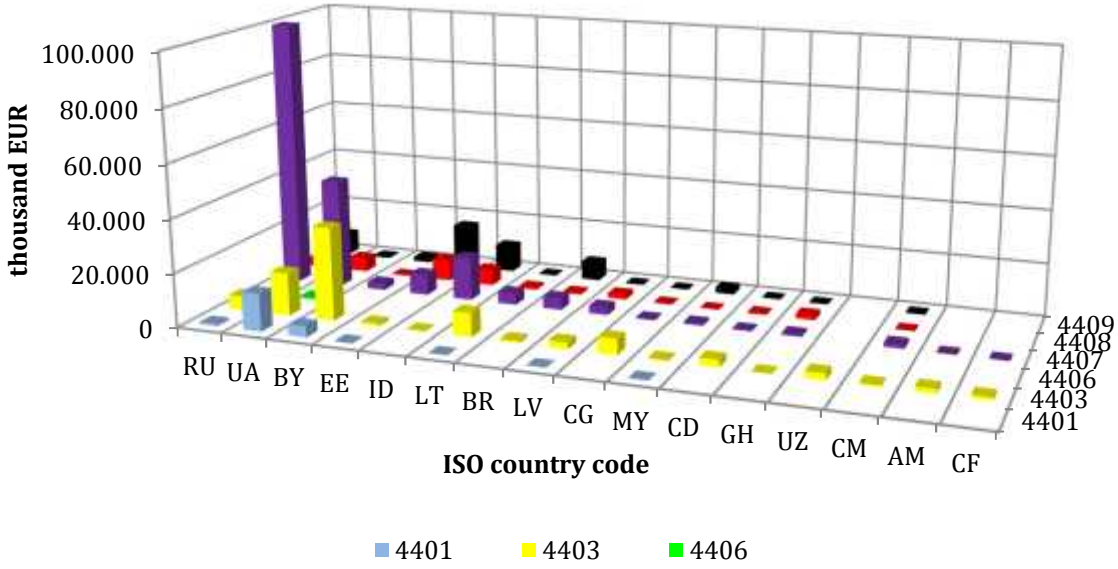
Data: Czech Statistical Office 2014, own processing

Codes of the Combined Nomenclature:

- 4401: Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms; wood in chips or particles; sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms.

- 4403: Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared.
- 4406: Railway or tramway sleepers (cross-ties) of wood.
- 4407: Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm.
- 4408: Sheets for veneering (including those obtained by slicing laminated wood), for plywood or for other similar laminated wood and other wood, sawn lengthwise, sliced or peeled, whether or not planed, sanded, spliced or end- jointed, of a thickness not exceeding 6 mm.
- 4409: Wood (including strips and friezes for parquet flooring, not assembled) continuously shaped (tongued, grooved, rebated, chamfered, V-jointed, beaded, moulded, rounded or the like) along any of its edges, ends or faces, whether or not planed, sanded or end-jointed.

Figure 1 shows the structure of imports by the respective codes expressed by the value of imports in market prices as in Table 1 (selected countries are indicated using ISO country code). The value of imports by the individual codes represents their sum for each country in the period from 2005-2013.



Data: Czech Statistical Office 2014, own processing

Figure 1. Structure of imports to the Czech Republic from selected countries in the period from 2005-2013 in thousands EUR – market prices

Table 2. Total value of imports to the Czech Republic from risky countries in the period from 2005-2013 in thousands EUR – market prices

Commodity code	Year									Total
	2005	2006	2007	2008	2009	2010	2011	2012	2013	
	thousand EUR									
4401	1	30	81	66	1,822	4,046	3,736	3,839	5,555	19,176
4403	4,363	5,201	4,696	3,039	4,631	11,016	15,033	19,562	18,702	86,243
4406	1	0	0	4	0	31	152	233	327	748
4407	21,972	20,170	22,478	21,523	17,125	21,863	25,359	19,739	17,341	187,570
4408	4,297	2,782	2,306	3,901	2,818	3,004	3,518	4,338	3,395	30,359
4409	6,829	6,507	5,991	5,658	4,755	4,146	4,231	4,713	4,299	47,129
Total	37,463	34,690	35,552	34,191	31,151	44,106	52,029	52,424	49,619	371,225

Data: Czech Statistical Office 2014, own processing

The value of all imports to the Czech Republic from risky countries according to commodity codes in the period from 2005-2013 is presented in Table 2. The total value of imports in the studied period amounted to 371.225 million EUR in market prices. Thus, the analysed imports from the above-listed 16 countries represented over 97% of all commodities imported to the Czech Republic from risky countries in the period from 2005-2013.

5. CONCLUSION

Based on the carried out analyses, it is possible to state that the requirements of the PEFC C-o-C standard are nearly compatible with the requirements of EUTR legislation. There are only two vulnerabilities in the PEFC C-o-C standard requirements, which can be quickly solved. The risks of launching wood or wood-based products from the controversial sources of the Czech Republic are minimal. The situation is different in the case of imports where most of the observed products (expressed in monetary units) are imported to the Czech Republic from the Russian Federation, Ukraine, Republic of Belarus, Republic of Estonia and Republic of Indonesia. Operators importing wood-based products from these countries should become a subject for inspection from the part of competent authorities. As to imported volumes of wood-based products, the highest amounts come from countries outside the European Union. Analogically, there is a high risk that these imports will include also the raw wood material from controversial sources.

Acknowledgements: This work was supported by the National Agency for Agricultural Research, projects No. QJ1530032 and No. QJ1220313.

REFERENCES

1. Brack, D. (2006): Illegal Logging. Fairpolitics. Chatham House. Netherlands. Online: http://www.fairpolitics.nl/doc/fair_politics_eu/illegal_logging/Briefing_paper_Illegal_logging_Chatham_House_2006.pdf.
2. Commission (2012a): Commission Delegated Regulation (EU) No 363/2012 on the procedural rules for the recognition and withdrawal of recognition of monitoring organizations. EUR-Lex. Brussels. Belgium. Online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0363&from=EN.
3. Commission (2012b): Commission Implementing Regulation (EU) No 607/2012 on the detailed rules concerning the due diligence system and the frequency and nature of the checks on monitoring organizations. EUR-Lex. Brussels. Belgium. Online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0607&from=EN.
4. Dudík, R. (2014). Provázanost systému PEFC C-o-C s požadavky EUTR. Uvedení systému PEFC C-o-C podle požadavků TD CFCS 2002:2013 do souladu s požadavky právních předpisů v oblasti EUTR. [CD-ROM]. Uplatněná certifikovaná metodika, osvědčení MZe č.: 86824/2014-MZE-16222/M92. ČZU v Praze. s. 50. ISBN 978-80-213-2535-7.
5. Dudík, R., Šišák, L. (2014): Placing Timber and Timber Products on the Market in the Czech Republic and Related Economic Impacts. In Schiberna, E., Stark, M. (Eds.), Adaptation in Forest Management under Changing Framework Conditions. Proceedings IUFRO Symposium. Foundation for Sustainable Forest Management, 35-42.
6. Dudík, R., Riedl, M. (2015): The possibilities of using C-o-C certifications in the Czech Republic. In Jelačić, D. (Ed.), Wood processing and furniture manufacturing challenges on the world market: proceedings of scientific papers. Dubrovnik: WoodEMA, 229-233.
7. EU (2010): Regulation (EU) No 995/2010 of the European Parliament and of the Council laying down the obligations of operators who place timber and timber products on the market. EUR-Lex. Brussels. Belgium.

Online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010R0995&qid=1399218300589&from=EN.
8. Guertin, C. (2003): Illegal Logging and Illegal Activities in the Forestry Sector: Overview and Possible Issues for the UNECE Timber Committee and FAO European Forestry Commission. UNECE Timber Comittee Market Discussions. Geneva. Switzerland Online: http://www.illegal-logging.info/uploads/Geneveconference_finale.pdf.
9. Heeswijk, L. (2010): Combating Illegal logging: the EU-FLEGT Action Plan. Netherlands. Online: http://www.vpa-livelihoods.org/publications.aspx.
10. MoA (2009): Zpráva o stavu lesa a lesního hospodářství České republiky v roce 2008. Ministerstvo zemědělství. Praha. Česká republika. Online: http://www.uhul.cz/images/ke_stazeni%5Czelenazprava/ZZ_2008.zip.
11. Paluš, H., Parobek, J., Kaputa, V. (2014): The role of forest certification in the European timber regulation. In Šupín, M., Paluš, H. (Eds.), Position and role of the forest based sector in the green economy: proceedings of scientific papers. Zagreb: WoodEMA, 111-117.

Authors address:
Dudík Roman
Department of Forestry and Wood Economics, Faculty of Forestry and Wood Sciences, Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Praha 6, Czech Republic
ro.dudik@gmail.com

VOLUME ESTIMATION OF SAWMILL WASTE IN FORESTRY RESEARCH INSTITUTE OF NIGERIA (FRIN)

Areo, O.S., Adejoba, O.R and [2]Omole, O.A

ABSTRACT

One of the factors identified contributing to forest loss is the amount of wood waste generated during conversion. This study analysed volume estimates of timber conversion at the sawmill section of Forestry Research Institute of Nigeria, Ibadan, Oyo State, Nigeria. Twenty-three logs from different wood species were available in the mill during the conversion process for monitoring. The percentage total wood waste generated during conversion process at the mill was found to vary for the species. The percentage waste generated for Terminalia cattapa, Triplochiton scleroxylon, Khaya senegalensis and Melicia excelsa are 11.7%; 33.6%; 17.4% and 15.1% respectively, similarly the log volumes are 2354m^3, 6791m^3, 3519m^3 and 3614m^3. This shows that the waste generated from the saw-mill during conversion is a little bit lower compare to the logs. The percentage of recovery of the species was found to be significantly different. The study shows that conversion efficiency of the mill is comparably low; this has the potential of increasing demand for more logs and forest exploitation. There is a need for improved technology that promotes efficient and effective timber conversion to facilitate sustainable timber exploitation in the mill.
Keywords: Sawmill, round log, wood waste, volume, conversion process.

1. INTRODUCTION

The sawmill industry in Nigeria was among the most developed sectors of the nation's economy in the 1960s to the early 1970s contributing about 70% of the country's Gross Domestic Product (GDP) (Ogunwusi, 2012). Sawmilling has been defined as the process of converting round wood from the forests into lumber by using a variety of machines. Some of the machines include bandmills, capable of breaking down logs into desired specifications and re-sawing machines for processing the cants and flitches into specified and marketable dimensions (Lucas,1995, Aina,et al 2004.). Sawmilling is a primary industry which provides raw materials to other industries such as construction, joinery, furniture and others. Sawmills can be categorised according to size, machinery and raw materials requirements (Weerawansa and Amarasekera 1997; Caldera and Amarasekera, 2015). However, in recent years, sawmills in Nigeria are undergoing a difficult period as a result of a multiplicity of factors (Ogunwusi, 2012). Most sawmills are depreciated, have a low recovery rate of less than 53% and lacks the capacity to process small diameter logs from forest plantations (FOSA, 2009). Low recovery rate, as well as a lack of capacity to process small diameter logs from tree plantations by sawmills have been discovered as significant drivers of deforestation and forest degradation in Nigeria.This disturbing paradigm is slowing down the development of forest industries in the country. In Sawmilling operations, waste is produced and are usually referred to as losses even though they could be put into other uses (Akachuku, 2000).

Awe (2000) describes conversion as a measure of sawmill efficiency and it is defined as the percentage volume of sawn timber that can be cut from a given volume of debarked log. Waste in sawmill is classified as avoidable and unavoidable wastes. Unavoidable waste include the sawdust, slabs, wanes and bark while the former are the absence of substandard lumber dimensions which often result from improper sawing, poor conditions of saw blades and lack of proper log impaction before sawing, hence Gbadamosi (1983) reported that to produce 1m^3 of sawn wood, 2.2m^3 of log is needed.

It is, therefore, evident that a large proportion of wood input is converted to wastes and this represents a substantial loss in monetary value and ultimately increased pressure on available timber resources.Therefore, this study is to estimate the percentage volume of wood wastes been generated during sawmilling operation in FRIN owned sawmills in order to determine the percentage input and output of logs.

1.1 Volume estimation

Wood volume is a cubic measure of the amount of wood, or wood plus bark, present in an individual tree, group of trees, or stand. Volume is usually measured in cubic meters, but may be measured in other units specific to intended commercial products and the statistical process of deriving information about a tree as a function of the measured trees variable. Standard volume tables (equations) are often used to estimate tree volume as a function of tree diameter and height for both routine forest measurement and for forest research purposes. A recognized shortcoming is that a standard volume table (equation) may fail to estimate the volume of sample trees in a specific stand. This may happen if the actual taper of the sample trees of a stand differs from the average taper of the trees used in the construction of the volume equation. Use of these volume equations ignores the variation that occurs because of taper differences.

1.1.1 Factors influencing lumber yield.

Factors influencing lumber yield and value have been identified as the factor influencing the timber recovery from logs during conversion in the mills. These include: log shape (sweep, tape crooked and straight), log sizes (girth and the length). Kinds of conversion and processing machine, machine maintenance culture, availability of machine parts and experience of the operators (Badejo, 1990). According to Zobel and Talbert (1991), log straightness improves both yield and quality of timber. In order to reduce the volume of wood wastes in the log conversion process and sustain the sawmills and corresponding profit margin, there should be an intensive research focus on efficient conversion of the log so as to stem down the percentage of waste in Nigeria sawmills (Badejo, 1990).

2.MATERIALS AND METHODS

Study Area: The study was carried out in FRIN,

lat $7^0$23’20N,long 3^0 51’20E

Fig 1: Aerial survey of FRIN

2.1 Log dimension and volume estimation

A total of 23 logs of varying sizes and shapes were sourced from four (4) timber species available in the sawmills at the time of this study and they are: Melicia excelsa, Terminalia catappa, Khaya senegalensis, Triplochiton scleroxylon.

Plate 1: Showing logs deposited in the logyard of CD6 sawmill.

Plate 2: Showing sawdust in the CD6 sawmill

Measurement of large end diameter, the small end diameter and as well as the length of the logs was recorded. The processing was done using the CD bandsaw machine in the department of Forest Products Development and Utilization in FRIN. The log volume and waste generated were determined during conversion using (a) measuring tape of 15m length and the following analysis was done using a Smalian method to estimate the log volume.

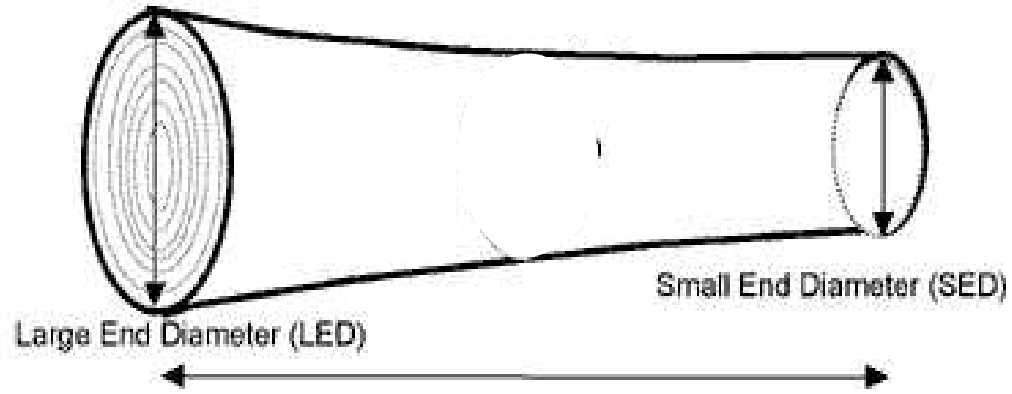


Plate 3 ; Showing CD Bandsaw machine

Plate 4: Showing CD6 Bandsaw machine

2.1.1 Volume Estimation of Wood Waste Estimation of Total Volume of Log

Total volume of log was estimated using the formula

$$V = \frac{(D + d)}{2} \times L$$

Where:
V = Volume of round log measured over bark
D = Cross sectional area of large end of log
d = Cross sectional area of a small end of a log
L = Length of a log

Estimation of Volume of Sawdust

The volume of sawdust is the total volume of the kerf.
Therefore volume of sawdust
Where:
K = Kerf
K = (kerf width) × (width of the cut surface) × (length of log).

3.RESULTS AND DISCUSSION

These results show the estimated volumes of logs to the volume of sawdust observed in the sawmill (CD6) at FRIN as represented in Tables 1-4. The calculated average volumes of total logs and wood waste are represented in Table 5. For Terminalia cattapa, the log volume is 23535m^3 with sawdust waste of 11.664%; Triplochiton scleroxylon, log volume of 679125m^3 with sawdust waste of 33.552%; Khaya senegalensis, the log volume is 35193.8m^3 with sawdust waste of 17.3916%; and Melicia excelas, the log volume is 36127.5m^3 with sawdust waste of 15.0855%. This shows that the waste generated from the saw-mill during conversion is a little bit lower and efficient in. accordance to Ekhuemelo and Atondo (2015) efficiency of wood conversion in sawmills implies that wood residue generated during conversion is reduced to bearest minimum. This as a result of smaller kerf width of the blade, the smaller the sawdust generated.

Table 1: Volume estimation of Terminalia cattapa using CD6 Bandsaw machine.

S/N	Length	Lower end(mm)	Butt	Volume est.(mm)	V.E (cm^3)	Width Of C.S(mm)	Width x Length	Sawdust (mm)	Sawdust (m^3)
1	3600	1675	1950	6525000	652500	2787.5	10035000	321120	321.12
2	3600	1925	2350	7695000	769500	3312.5	11925000	381600	381.6
3	3600	2300	2875	9315000	931500	4025	14490000	463680	463.68

Source: Field Survey, 2016.

Table 2: Volume estimation of Triplochiton scleroxylon using CD6 Bandsaw machine.

S/N	Length	Lower end(mm)	Butt	Volume est.(mm)	V.E (cm^3)	Width Of C.S(mm)	Width x Length	Sawdust (mm)	Sawdust (m^3)
1	2100	1600	1750	3517500	351750	2550	5355000	171360	171.36
2	2700	1050	1375	3273750	327375	1900	5130000	164160	164.16

Source: Field Survey, 2016.

Table 3: Volume estimation of Khaya senegalensis using CD6 Bandsaw machine.

S/N	Length	Lower end(mm)	Butt	Volume est.(mm)	V.E (cm^3)	Width Of C.S(mm)	Width x Length	Sawdust (mm)	Sawdust (m^3)
1	3000	1300	1700	4500000	450000	2350	7050000	225600	225.6
2	2100	1000	1275	2388750	238875	1775	3727500	119280	119.28
3	1800	1625	1725	3015000	301500	2538	4567500	146160	146.16
4	2700	1200	1275	3341250	334125	1875	5062500	162000	162
5	2700	800	1225	2733750	273375	1625	4387500	140400	140.4
6	2700	850	1025	2531250	253125	1450	3915000	125280	125.28
7	1800	1000	1625	2362500	236250	2125	3825000	122400	122.4
8	3600	1350	1650	5400000	540000	2325	8370000	267840	267.84
9	3600	1675	1650	5985000	598500	2488	8955000	286560	286.56
10	2700	1025	1150	2936250	293625	1663	4488750	143640	143.64

Source: Field Survey, 2016.

Table 4: Volume estimation of Melicia excelsa using CD6 Bandsaw machine.

S/N	Length	Lower end(mm)	Butt	Volume est.(mm)	V.E (cm^3)	Width Of C.S(mm)	Width x Length	Sawdust (mm)	Sawdust (m^3)
1	1450	1425	2700	3881250	388125	3412.5	4948125	158340	158.34
2	900	280	3600	2124000	212400	3740	3366000	107712	107.712
3	2400	1520	3600	7056000	705600	4360	10464000	334848	334.848
4	1500	1200	2700	3645000	364500	3300	4950000	158400	158.4
5	1750	1800	2100	3727500	372750	3000	5250000	168000	168
6	1375	1575	3600	5310000	531000	4387.5	6032813	193050	193.05
7	900	1025	2700	2598750	259875	3212.5	2891250	92520	92.52
8	1925	2400	3600	7785000	778500	4800	9240000	295680	295.68

Source: Field Survey, 2016.

3.1 Volume of Log to Volume of Sawdust.

Table 5: Volume of Log to Volume of Sawdust.

Species	Sawdust (m^3)	Log Volume(m^3)	Sawdust (%)	Log Vol. (%)
Terminalia cattapa	1166.4	23535	11.664	235.35
Triplochiton scleroxylon	335.52	6791.25	3.3552	67.9125
Khaya senegalensis	1739.16	35193.8	17.3916	351.9375
Melicia excelas	1508.55	36127.5	15.0855	361.275

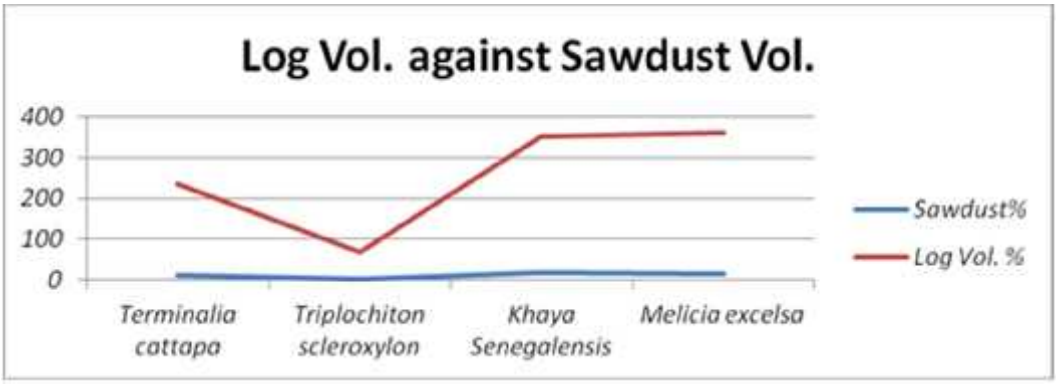


Fig 2: Graph showing Log Volume against Sawdust Volume

4. CONCLUSION

Volume estimation of sawmill wastes is important in order to know a number of wood wastes during the conversion process. This shows the efficiency of the process of conversion in the sawmill at the Institute is relatively efficient and observed reduction in waste generated in the sawmills could be attributed to training and regular skill upgrading programme of the technical staff. It is, therefore expedient to encourage the use of sawmill wastes hitherto increasing the profit in sawmilling business, generation of biofuel and other uses.Its, therefore recommend that proper and efficient utilization of wood wastes by saw millers and the government should be encouraged so as to increase profitability and reduce deforestation. Saw millers should be exposed to extension services on the best way to manage their saw-mills so as to reduce sawmill wastes. More research should be carried out on wood wastes utilization.

REFERENCES

1. Akachuku, A.E. (2000): Sawmilling wastes in Nigeria and its effect on the environment. The Nigerian Field:219-233.
2. Aina, O.M., and Adekunle, M.F. (2004): Socio-economic assessment of sawmills and sawmilling wastes for sustainable environmental resources management in Abeokuta, Ogun State. In Adeofun et al. (eds.) Proceedings of the 12th Annual Conference of EBAN, UNAAB, Abeokuta 24th – 26th Nov., 2004. p 27-32.
3. Awe, O.A. (2000): Assessment of wood conversion efficiency in some sawmills in Ondo State, Unpublished ND project, Federal College of Forestry, Jericho, Ibadan
4. Badejo, S.O.O. & Giwa, S.A. (1985): Volume Assessment and Economic Importance of Wood Waste Utilization in Nigeria. Technical Report No. 50, Forestry Research Institute of Nigeria (FRIN). pp15-31
5. Badejo, S.O.O. and Onilude, M.A. (1990). An Appraisal of the small size sawmilling operation in Nigeria. Lumber Conversion Ratio as case study.
6. FOSA (2009): Forestry Outlook Studies in Africa: Nigeria. Ministry of natural resources and tourism. (availableathttp://www.fao.org/docrep/004/ab592e/AB592E01.htm).
7. H.T.S. Caldera and H.S. Amarasekera (2015). Investigation of Sawmill Management and Technology on Waste Reduction at Selected Sawmills in Moratuwa, Sri Lanka. Journal of Tropical Forestry and Environment Vol. 5. No 01 (2015) 71-82.
8. Lucas, E.B. (1995): Wasted tree products in Nigeria, (their causes, extent, and characteristics). Nigerian Journal of Forestry, 5(1 & 2): 24-30.
9. Ogunwusi, A. (2012): The Forest Products Industry in Nigeria. African Research Review6(4):191-205.
10. Ekhuemelo, D.O., and Atondo, T.M (2015). Evaluation of Lumber Recovery and Waste Generation in Selected Sawmills in Three Local Government Areas of Benue State, Nigeria. Journal of Applied Tropical Agriculture. A publication of the school of Agriculture Technology, The Federal University of University, Akure, Nigeria. 62-68pp
11. Weerawansa, P.S., and Amarasekera, H.S. (1997): Evaluation of the sawmilling wastage of sawmills in the western province of Sri Lanka, Proceedings of the 3rd Annual Forestry Symposium of the Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Sri Lanka.

Author Address:
Forestry Research Institute of Nigeria, P.M.B 5054, Jericho hill, Ibadan
[2]Forest Resource Management Department, University of Ibadan, Ibadan, Nigeria
*Corresponding author: areosola73@gmail.com, +2348055301260

ISBN 978-0-692-76612-5
9780692766125